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ABSTRACT

Designed for students in the ninth grade, this electricity/electronics curriculum guide contains instructional modules for twenty-four units of instruction. Among the modules included are (1) introduction to the world of electricity, (2) electrical safety, (3) the electrical team, (4) resistance and resistors, (5) electric lamps and heating devices, (6) motors and generators, (7) low voltage circuit wiring of signal devices, (8) house wiring, (9) communication systems, and (10) exploring occupations in electricity and electronics. Each instructional module is divided into two sections. The first section is an instructor's guide which enables the instructor to have a lesson plan overview to the unit. This overview includes the title of the unit, time allocation, unit goal, unit objectives, evaluation, instructor references, unit overview, suggested presentation hints/methodology, supplemental activites and demonstrations, and instructional module contents listing. Section 2 of the module contains the packet of materials to be utilized in the classroom. Each packet includes the following parts: unit outline/transparency master, pre-post test, vocabulary enrichment activities, student informational handouts, related quest activities, and answer keys. (LRA)

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INDUSTRIAL EDUCATION

ELECTRICITY / ELECTRONICS

CURRICULUM
GUIDE
PHASE II

INSTRUCTIONAL MODULES
LEVEL II

U S DEPARTMENT OF HEALTH.
EDUCATION & WELFARE
NATIONAL INSTITUTE OF
EDUCATION

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STATE OF CALIFORNIA

BUREAU OF INDUSTRIAL EDUCATION
DEPARTMENT OF EDUCATION

INSTRUCTIONAL MODULES

A set of 24 technical units which were specifically designed to support Electricity/Electronics instructors in the planning and presentation of their course materials.

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DEDICATION:

To our parents who taught us the importance of education and that learning is truly a lifelong process.

Angelo E. & Dorothy L. Lillo

Nicholas A. & Alice L. Soffiotto

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TABLE OF CONTENTS

Page

ACKNOWLEDGEMENTS. ii

Project Staff ii

Special Contributors . . . . ii-iii

Other Contributors iii

PREFACE iv

Industrial Education iv

INTRODUCTION. v

Philosophical Background v

Project Purpose Phase I. . . . . . . v-vii

Project Purpose Phase II vii

ORIENTATION viii

Rationale viii

Scope . . . . viii-ix

Support Systems. . . . . ix-x

MODULE LISTING xi

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PREFACE

Industrial Education, in the public schools of California, is a generic term which applies to all levels of education and training which relate directly to industrial occupations. Industrial Education includes the major subject matter fields of industrial arts, trade and industry, and technical and health careers and services. A comprehensive and reflective Industrial Education curriculum will assist and support students in selecting, preparing, and advancing in occupations or careers which currently exist or which are emerging.

Industrial Education programs are also those educational programs which pertain to the body of related subject matter organized for the development of understanding about the technical, consumer, occupational, recreational, organizational, managerial, social, historical, and cultural aspects of industry and technology.

In essence, Industrial Education curriculum is concerned with aiding the individual to respond and react sensitively to technological developments and to cope efficiently and effectively with the consequences in one's personal life.

In order to provide skills for students to meet their employment needs in the future, the educational system must meet its curriculum challenges today. One means of solving this problem was the development of the State Electricity/Electronics Curriculum Guide Phase I, that centered on a competency-based cluster approach to derive curriculum. Phase II provides the necessary Instructional Learning Modules including classroom materials for a realistic curriculum foundation which will assist in developing student competencies for entry level occupations and/or technical specialization. Statewide application of these materials will allow for student mobility because of standardization and it avoids duplication of high cost instruction.

It is sincerely hoped that the educational materials contained in this curriculum project will serve as the foundation for improving instruction in the area of Electricity/Electronics within the school systems of California.

INTRODUCTION

Philosophical Background

One of the primary purposes of the public schools in our society is to acquaint the young with the nature of the culture within which they live and operate. The American culture is distinctly technological; therefore, it is the responsibility of our educational system to acquaint our youth with the nature of this technological culture. The tremendous acceleration of industrial technology has had and will continue to have an overwhelming impact on society.

One fundamental concept behind Industrial Education in our educational system is that technical experiences, curriculum, instruction, and guidance assist the student in preparation for economic independence and an appreciation for the dignity of work. Another main thrust is to prepare students for a successful life of work by increasing their options for occupational choice, by eliminating barriers to attaining job skills, and by enhancing learning achievement in all subject areas.

Irrespective of what the future may hold, individuals living in our present day environment will be handicapped unless they are reasonable well informed concerning the vast Electrical/Electronic technological applications in our daily living. Our present civilization is scarcely conceivable without the applications of Electricity/Electronics which have become identified with the industrial growth of our country and our thousands of everyday conveniences. The Electricity/Electronics subject field is an integral part of the Industrial Education curriculum, and this field provides employment for millions of individuals annually.

The total impact of Electricity/Electronics on human life is of such magnitude that it necessitates a comprehensive technical program in our schools to produce informed individuals capable of effective and meaningful functioning in our society.

Project Purpose Phase I

During the Industrial Revolution, Industrial Education focused on primary or single skill development, and this approach was viable in an era that required the mastery of one skill for initial employment. However, present technological developments in the labor market have necessitated that individuals within the labor force have a multiplicity of skills to meet the needs of the nation's trade and technological communities.

In order to facilitate methods for students to meet their employment needs in the future, the educational system must meet its curriculum challenges today. One means of solving this problem is the development of an Electricity/Electronics instructional program that centers on a competency-based cluster approach to derive curriculum. Utilizing this approach, the student will have a realistic curriculum foundation which will provide access to the necessary competencies for entry level occupations and/or technical specialization.

The basic intent of the State Electricity/Electronics Curriculum Guide was to provide educators within Industrial Education a competency-based guide that can be adapted or adopted to any existing or new program without major cost expenditures. Hopefully, the guide will act as a catalyst for educators who desire a revision or restructuring of their Electricity/Electronics curriculum, yet the guide format provides the flexibility for teacher-based modifications related to methodology, instructional resources, textbooks, equipment, laboratory systems, etc. For the educator, the heart of this guide was the curriculum outlines that were an outgrowth of the occupational tasks and/or competencies identified through various occupational needs assessments and tasks analysis inventories.

The following is a brief synopsis of each outline in terms of level of instruction and duration.

1. Curriculum Outline Level I - Grades 7-8
   a. 9 week unit outline
   b. 18 week unit outline
2. Curriculum Outline Level II - Grade 9
   a. 36 week unit outline
3. Curriculum Outline Level III - Grade 10
   a. 36 week unit outline
4. Curriculum Outline Level IV (Specialization Level) - Grades 11-14
   a. 36 week unit outline at each grade level

The contents of the curriculum outlines were generated to increase the efficiency of the Electricity/Electronics programs in the schools of this State, and the competency based structure was established for the students so that their complex and confusing world begins to take on order and their learning tasks are more relevant and readily attained.

Project Purpose Phase II

The State Electricity/Electronics Curriculum Guide was proposed as a comprehensive educational guide designed to eliminate the dichotomy between formal school and the world of work. Basically Phase II allowed the development of Learning Modules for the Guide, in an effort to improve the preparation of California's youth for their future in the world beyond the classroom.

Phase II also addressed itself to the development and use of Instructional Modules within the classroom as a vehicle to implement the Curriculum Outlines presented in Phase I.

Instructional Modules were based on each major unit topic within Levels I, II and III of the State Curriculum Guide for Electricity/Electronics. Approximately sixty Instructional Modules or packets were created for teacher/student use. Each module contains basically the following:

1. Goals and Objectives (unit)
2. Outline
3. Pre-Post Test (keyed)
4. Instructor References
5. Suggested Methodology
6. Demonstrations and Quest Activities
7. Student Handouts--Informational
8. Vocabulary Enrichment List
9. Student Worksheets
10. Related Instructional Activities and Graphical Illustrations

ORIENTATION

Rationale

The Instructional Modules in this level were specifically designed to assist the electronics instructor in the planning, organization, and presentation of course materials. Care and emphasis throughout the modules has been given to the needs of technical instructors who must motivate and guide California's youth through the educational system. At the same time the authors of the Instructional Modules were fully cognizant of the need to present fundamental competencies, yet, not in the traditional dry fashion but with an eye towards:

Marketing the Subject Matter
Innovative Assignments
Eye Appeal
Constant Reinforcement
Educational Games
Doing Activities
Immediate Unit Evaluation
"State of the Art" Subject Matter
Diversity in Teaching Methodology

Scope

The Instructional Modules are generally divided into two sections, as follows:

Section I (Instructor's Guide)

This section is presented first in the module to enable the instructor to have a lesson plan overview to the unit. This overview includes;

1. Title of Unit
2. Time Allocation
3. Unit Goal
4. Unit Objectives
5. Evaluation
6. Instructor References
7. Overview (unit)
8. Suggested Presentation Hints/Methodology
9. Supplemental Activities and Demonstrations
10. Instructional Module Contents Listing

All of the suggestions in this section were designed to enhance the unit presentation and provide the most effective learning environment for utilization of all instructional materials. The contents of each module have been carefully prepared and scrutinized in order to establish a solid technical foundation for the student.

Section II (Instructional Module Materials)

This section contains the packet of materials to be utilized in the classroom. When appropriate each module includes;

1. Unit Outline/Transparency Master
2. Pre-Post Test (keyed)
3. Vocabulary Enrichment Activities
4. Student Informational Handouts
5. Related Quest Activities
6. Answer Keys

The Instructional Modules have been constructed and packaged so that the deletion of certain materials or the addition of pertinent information can be inserted or removed with minimal difficulty. Individual courses and instructors are not identical hence provision for flexibility is necessary in order to achieve a curriculum that is compatible with the instructor.

In the event a training program requires a radical change in the content of material presented within a module, the instructor may easily cut, insert, and paste masters to achieve the desired results which are tailored to the instructors specific needs.

Support Systems

No amount of planning or preparation can guarantee success in the classroom, because learning is such an intangible quality, yet, the lack of these ingredients in any program immediately guarantees dismal educational results. The most indispensable support system within the educational process is the teacher, who must have the expertise and enthusiasm that can propel students into the world of learning.

The instructor must also possess the drive and ambition to continuously improve and update the program, especially in this area, due to dramatic technological innovations.

The classroom should contain the necessary furniture to allow the course to be taught in a satisfactory manner. Good lighting is absolutely essential in terms of the activities that occur. Power outlets are of paramount concern for obvious reasons, and their location should allow for room flexibility. Tables, benches, and/or desks should contain locks to insure inventory control, and storage facilities for projects, equipment, parts, etc., must be readily available. Chalkboards and bulletin boards should be mounted for easy access within the classroom.

The field of Electricity/Electronics seems to be a natural interest area to many students and the laboratory portion can be used as the vehicle to generate a vast amount of enthusiasm along with necessary technical concepts. Whether an instructor utilizes individual experiments, project construction, training systems, or a combination approach in their laboratory is not critical; what is vital is that their selection reflects the goals and objectives that they want to attain within the course.

An individual school may have the best physical facility, equipment, instructional materials, and administration, but in the final analysis it is the teacher who must promote, coordinate and maintain the program.

MODULE LISTING

Curriculum Guide Phase II

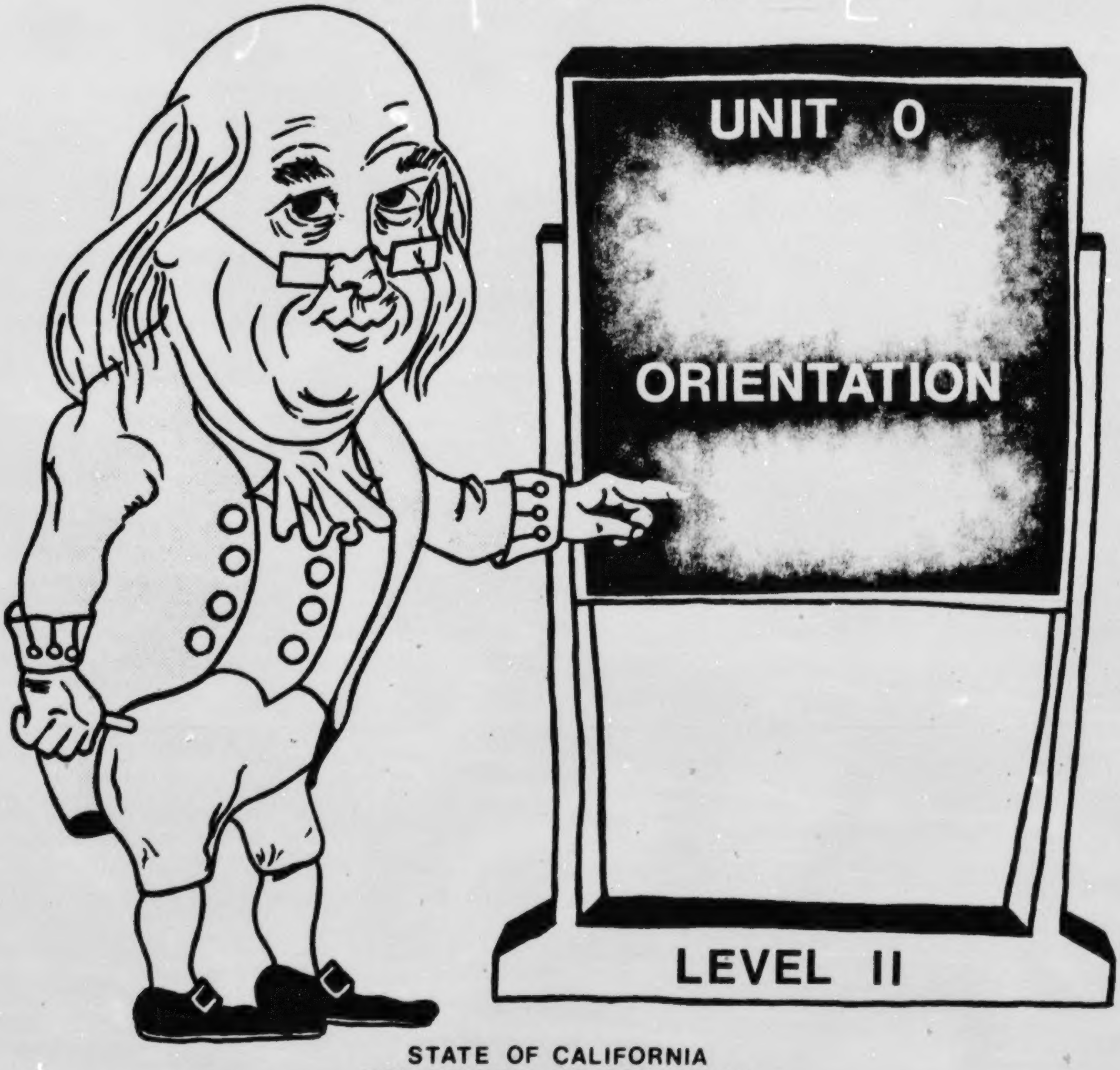
Level II Instructional Modules*

Unit	0	Orientation
Unit	I	Introduction to the World of Electricity
Unit	II	Electrical Safety
Unit	III	Historical Development of Electricity
Unit	IV	Basic Electrical Skills
Unit	V	Magnetism
Unit	VI	Nature of Electricity
Unit	VII	Methods of Producing Electricity
Unit	VIII	The Flow of Electricity Through Conductors and Insulators
Unit	IX	The Electrical Team
Unit	X	The Language and Symbols of Electricity
Unit	XI	Components, Switches, and Circuits
Unit	XII	Resistance and Resistors
Unit	XIII	Electric Lamps and Heating Devices
Unit	XIV	Electromagnetism
Unit	XV	DC and AC Electricity
Unit	XVI	Motors and Generators
Unit	XVII	Low Voltage Circuit Wiring of Signal Devices
Unit	XVIII	Circuit Protection Devices
Unit	XIX	House Wiring
Unit	XX	Introduction to Electronic Math Fundamentals
Unit	XXI	Communication Systems
Unit	XXII	Exploring Occupations in Electricity and Electronics
Unit	XXIII	Your Future in Electricity and Electronics

*Instructional Module contents are coordinated with the California Industrial Education Electricity/Electronics Curriculum Guide, Level II, Curriculum outlines.

ELECTRICITY / ELECTRONICS

CURRICULUM GUIDE
INSTRUCTIONAL MODULE


UNIT 0
ORIENTATION
LEVEL II

STATE OF CALIFORNIA
DEPARTMENT OF EDUCATION

NAME________________
DATE STARTED___________
DATE COMPLETED________

BY
R. E. LILLO
N. S. SOFFIOTTO

STATE ELECTRICITY/ELECTRONICS CURRICULUM GUIDE
INSTRUCTOR'S GUIDE TO ACCOMPANY LEVEL II UNIT #0

Title of Unit: Orientation

Time Allocation: Several Days

Unit Goal:

To communicate those competencies which will allow an awareness of course goals, objectives, and basic requirements.

Unit Objectives:

The student will be able to:

1. describe examples of the technical nature of our modern society and the need for technical instruction in the area of Electricity/Electronics.
2. explain basic course requirements and the system of student evaluation.
3. demonstrate an awareness of the general course objectives and verify the significance of each within this educational program.

Evaluation:

The student will demonstrate his/her competence in terms of these measurable objectives based upon individual instructors acceptable performance criteria, which may utilize a combination of oral, or written testing procedures.

Instructor References:

Industrial Education Electricity/Electronics Curriculum Guide Grade Levels 7-14. Published by the State of California, 1977.

Innovative Programs In Industrial Education. Leslie H. Cochran, McKnight and McKnight Co., 1970. Chapters 5, 6, and 7.

Planning and Organizing Instruction. Ralph C. Bohn and Harold Silvius, McKnight and McKnight Co., 1976.

Overview:

This unit should be introduced by examining the course goals and objectives, not merely an instructor/student exercise in reading, but a brief discussion in reference to each item while also highlighting their overall significance.

Basic school or classroom rules and regulations, or operating procedures require attention early and this may be a good opportunity to present those to the class.

The next topic should emphasize specific course requirements and the method for student evaluation. Time should be allocated in such a manner that it will allow extensive descriptions as needed.

This unit will not conclude with an examination as will other modules, because of the length and nature of the subject matter presented.

Suggested Presentation Hints/Methodology:

Follow the instructional module unit outline as a basic skeleton for curriculum presentation, however, note the following:

1. This unit can afford the instructor an unusual opportunity to learn about important qualities the student possesses. The Student Questionnaire for example can act as a means to discover a wealth of information, so read through it carefully upon completion, then file all student forms by periods in one notebook for a handy reference.
2. The handout labeled "Student Performance Record" can serve several functions as desired. First, it can be placed at the front of the students' notebook as a title page, or it can be graded periodically to indicate unit performance as evaluated by instructor. Finally, this handout could be a quick Table of Contents for students in terms of specific course content and/or subject matter chronology.
3. When introducing the Informational Handout - Electricity/ Electronics, (area description) have each student read out loud a small portion. This will immediately draw your attention to those students that might need special attention.
4. Remember detailed Rules for Conduct and Procedure are located in the safety unit and will be taught at a later time. This unit is only concerned with basic classroom conduct and procedures.

Supplemental Activities and Demonstrations:

1. Initial room impressions are important so if possible have the bulletin boards adequately displayed, materials stored properly, safety signs posted, etc. These kinds of things such as shop appearance develop student attitudes that will affect their own craftmanship or performance.
2. During the first week of school many students can be disenchanted with the "paper shuffling" so try to demonstrate a technical device that can catch their imagination. If a strobe light, color organ, or even a microcomputer is available use it to generate enthusiasm about the program.

Instructional Module Contents:

1. Unit Outline (overhead)
2. Informational Handout (Course Goals and Objectives)
3. Informational Handout (Electricity/Electronics Area Description)
4. Informational Handout (Student Questionnaire)
5. Informational Handout (Student Performance Record)
6. Informational Handout (Student Evaluation System)
7. Exam Answer Sheet (Master)

0. Orientation

   A. Course Objectives

   B. Rules for Conduct and Procedures

   C. Course Requirements

Name: ______________

Date: ______________

Period: ______________

INFORMATIONAL HANDOUT

COURSE GOALS AND OBJECTIVES

This Electricity/Electronics program is a technical educational program designed to insure that all individuals are prepared with "entry" level skills to enter either the world of work or to continue to post-secondary education.

Listed below for your review are some general objectives that will be accomplished with the successful conclusion of this course!

- An appreciation of the influence the Electricity/Electronics area has on our social and economic life.
- The ability to select, care for, and utilize electronic products equipment and tools.
- An awareness of safe habits and attitudes regarding materials, tools, and equipment.
- Opportunities to explore leisure-time activities within this subject field.
- An appreciation of design, construction techniques, and craftsmanship.
- An understanding of the occupational composition of the Electricity/Electronics area within the world of work.
- The ability of problem-solving technical data by utilizing sound judgements based on valid knowledge and experience.
- A consciousness in regards to energy conservation and its significance.
- An awareness of consumer products and their technical operation and application.
- Demonstrations of basic technical proficiency skills that apply to a range of occupational jobs in Electricity/Electronics.
- The recognition of specific competencies essential for employment in a job area and the formation of realistic occupational goals.

Name: ____________________

Date: ____________________

Period: ____________________

INFORMATIONAL HANDOUT

ELECTRICITY/ELECTRONICS

Our grandparents would never recognize the world in which we live or many of the gadgets which are so common to us. Hundreds of electronic wonders which we readily accept in our society were unknown sixty years ago, and have become familiar objects only through the development of a new industry that is called electronics. This industry is now one of the largest in the United States, and a major portion of its research and production plants are located in California.

This school has recognized that present technology and consumer demands offe a special opportunity for students who want occupations which are interesting and challenging and where the chance for advancement and salary are unlimited. The electronics field is one in which continuous research is always adding new products to be made, tested, marketed, and operated. There will be a steady increase in the number of persons employed in this industry according to statistics developed by the State of California.

The student in Electricity/Electronics studies basic electrical theory, laboratory techniques, use of test instruments, care and use of hand tools, shop safety, circuits, and construction or project building. The skills whic one can develop may be applied to the areas of communication, transportation computers, research and development, etc.. If the student is deeply interested in his/her work, has abilities, and is willing to study and learn, s/he can progress to an entry level occupation or to continue further technical training.

Basically, electronics is a field that is a combination of the study of mathematics and physical science, and its principles can be understood by the individual who is willing to . . . . **WORK!**

Name: ____________________

Date: ____________________

Period: ____________________

INFORMATIONAL HANDOUT

STUDENT QUESTIONNAIRE

PLEASE PRINT

1. Name ______________________________ Phone ______________
   Last First Middle
2. Address ______________________________ Grade in School ______________
3. Age _____ Birthdate ______________________________
   Month Day Year
4. Father or Guardian's name ______________________________
   Last First Middle
5. Occupation ______________________________
6. Mother or Guardian's name ______________________________
   Last First Middle
7. Occupation ______________________________
8. What are your hobbies? ______________________________
9. Do you have a job? _____ What? ______________________________
10. What occupation would you like to follow? ______________________________
11. What type of education do you think is required for this occupation?
    ____
12. Previous shop courses

Previous shop courses	School	Grade level	Letter Grade
A. General Shop			
B. Drafting			
C. Woodwork			
D. Auto Shop			
E. Metal Shop			
F. Electricity			

13. List machines you have used in school or at home ______________________________

Name:

4. List hand tools you have used in school or at home

15. Why are you enrolled in this class?

16. Whom to contact in case of an accident

Address Phone

17. School Activities (athletic teams, clubs, etc.)

18. School Attended last year

19. List classes taken last year and letter grade for last semester.

	Class	Teacher	Grade
1.			
2.			
3.			
4.			
5.			
6.			

20. Class schedule this year.

Period	Class	Teacher	Room
1.			
2.			
3.			
4.			
5.			
6.			

21. Counselor

22. Write a brief autobiography, include where you were born, schools attended, interest, goals etc..

Name: ____________________

Date: ____________________

Period: ____________________

ELECTRICITY / ELECTRONICS

STUDENT PERFORMANCE RECORD

Name of student: ____
Last First Middle

UNIT			Unsatisfactory	Satisfactory	Excellent
0.	Orientation	0.			
I.	Introduction to the World of Electricity	I.			
II.	Electrical Safety	II.			
III.	Historical Development of Electricity	III.			
IV.	Basic Electrical Skills	IV.			
V.	Magnetism	V.			
VI.	Nature of Electricity	VI.			
VII.	Methods of Producing Electricity	VII.			
VIII.	The Flow of Electricity Through Conductors and Insulators	VIII.			
IX.	The Electrical Team	IX.			
X.	The Language and Symbols of Electricity	X.			
XI.	Components, Switches, and Circuits	XI.			
XII.	Resistance and Resistors	XII.			
XIII.	Electric Lamps and Heating Devices	XIII.			
XIV.	Electromagnetism	XIV.			
XV.	DC and AC Electricity	XV.			
XVI.	Motors and Generators	XVI.			
XVII.	Low Voltage Circuit Wiring of Signal Devices	XVII.			
XVIII.	Circuit Protection Devices	XVIII.			
XIX.	House Wiring	XIX.			
XX.	Introduction to Electronics Math Fundamentals	XX.			
XXI.	Communication Systems	XXI.			
XXII.	Exploring Occupations in Electricity and Electronics	XXII.			
XXIII.	Your Future in Electricity and Electronics	XXIII.			

(Place this sheet in the front of your notebook as a title page).

____________________ School

____________________ Instructor

Name: ____________________

Date: ____________________

Period: ____________________

INFORMATIONAL HANDOUT

STUDENT EVALUATION SYSTEM

Students are graded as follows each quarter:

CITIZENSHIP: _____%

The citizenship grade is determined by attitude, cooperation, work habits, clean-up, oral participation, and attendance.

This grade may be lowered as follows:

1. Unexcused absences.
2. Unexcused tardies.
3. Improper attitude or behavior.
4. Shop rule violations.

LABORATORY AND HOMEWORK: _____%

The laboratory/homework grade is based on the quality and quantity of the work completed at the end of each quarter.

This grade may be lowered as follows:

1. Quantity and quality below ability.
2. Inconsistent work or progress.
3. Required laboratory experiments, projects, or homework not completed.
4. Failure to observe safety regulations.

TESTS: _____%

This grade is determined by averaging quizzes, tests, and final examinations

NOTEBOOK: _____%

Notebooks will be collected and graded periodically. Notes will be neat, clear, and in proper sequence. They will contain all materials and assignments completed by students, and also those handed out by the instructor.

FINAL GRADE: _____%

The final grade is determined by a collection of grades in the following areas:

1. Laboratory and homework.
2. Citizenship/behavior.
3. Tests
4. Notebook

SCORE:
GRADE:

Name: ____________________

Date: ____________________

Period: ____________________

ANSWER SHEET

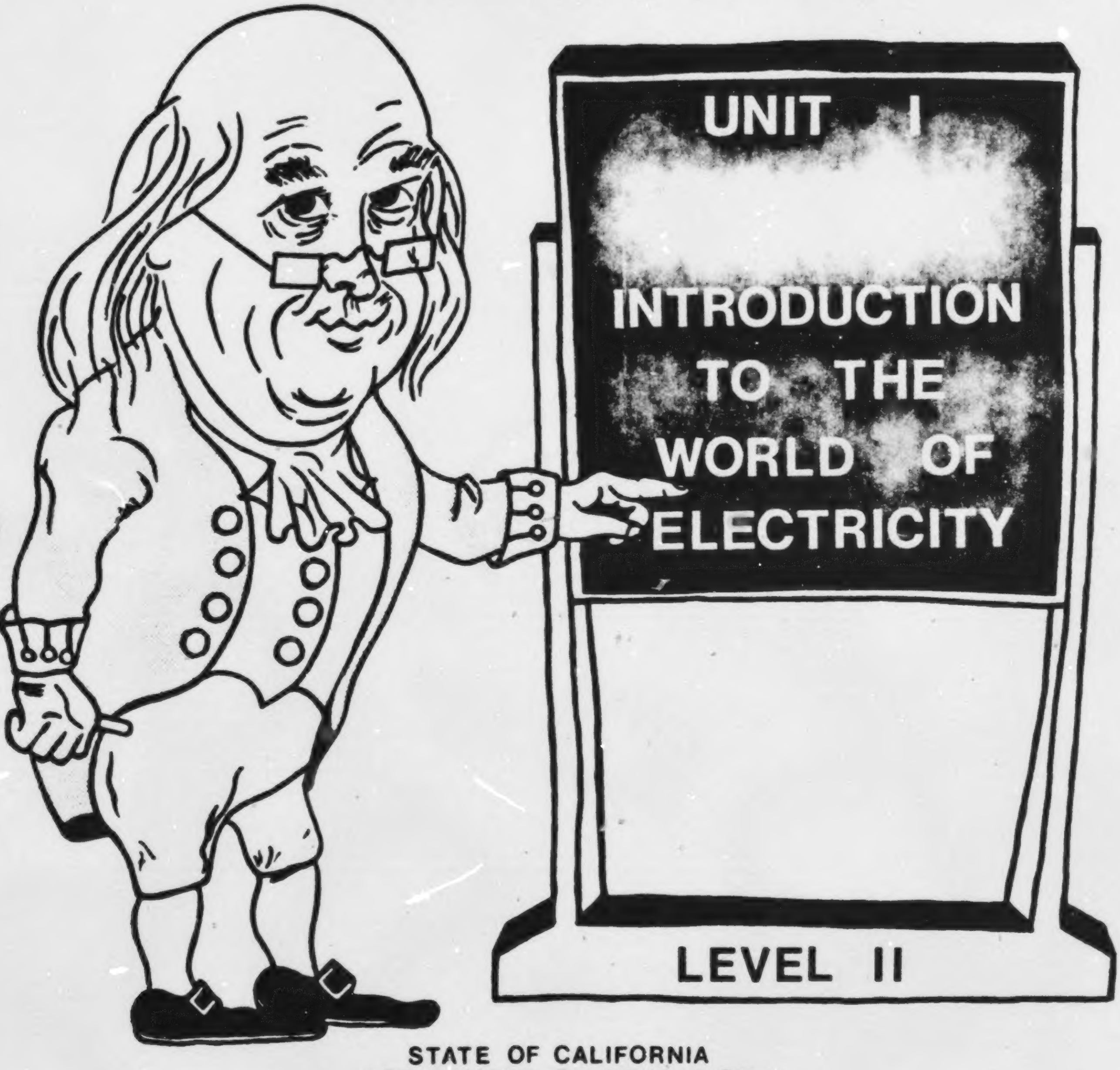
EXAM ____

	T	F				T	F				T	F				T	F		
	A	B	C	D		A	B	C	D		A	B	C	D		A	B	C	D
1.					26.					51.					76.				
2.					27.					52.					77.				
3.					28.					53.					78.				
4.					29.					54.					79.				
5.					30.					55.					80.				
6.					31.					56.					81.				
7.					32.					57.					82.				
8.					33.					58.					83.				
9.					34.					59.					84.				
10.					35.					60.					85.				
11.					36.					61.					86.				
12.					37.					62.					87.				
13.					38.					63.					88.				
14.					39.					64.					89.				
15.					40.					65.					90.				
16.					41.					66.					91.				
17.					42.					67.					92.				
18.					43.					68.					93.				
19.					44.					69.					94.				
20.					45.					70.					95.				
21.					46.					71.					96.				
22.					47.					72.					97.				
23.					48.					73.					98.				
24.					49.					74.					99.				
25.					50.					75.					100.				

*Show work for problems on back of answer sheet.

ELECTRICITY / ELECTRONICS

CURRICULUM GUIDE
INSTRUCTIONAL MODULE


UNIT I
INTRODUCTION TO THE WORLD OF ELECTRICITY
LEVEL II

STATE OF CALIFORNIA
DEPARTMENT OF EDUCATION

NAME____________________
DATE STARTED____________
DATE COMPLETED_________

BY
R. E. LILLO
N. S. SOFFIOTTO

STATE ELECTRICITY/ELECTRONICS CURRICULUM GUIDE
INSTRUCTOR'S GUIDE TO ACCOMPANY LEVEL II UNIT #1

Title of Unit: Introduction to the World of Electricity

Time Allocation: Several Days (Units 0 and 1 = 1 week)

Unit Goal:

To communicate and infuse those competencies which will permit students to evaluate the basic characteristics of electricity and to comprehend the dramatic role that electricity plays in our technical society.

Unit Objectives:

The student will be able to:

1. describe in general terms, what is electricity and identify several major applications.
2. define the terms static and/or dynamic electricity, and indicate an appropriate example of each type.
3. explain and/or justify the need for mastering fundamental theories related to the Electricity/Electronics field, and verify the importance of this field to modern society.

Evaluation:

The student will demonstrate his/her competence in terms of these measurable objectives based upon individual instructors acceptable performance criteria, which utilizes a combination of oral, or written testing procedures.

Instructor References:

Basic Electricity. Marcus and Marcus, Prentice-Hall, Inc., 1974.
Chapters: 1 and 2.

Basic Electricity Training Manual. Ted Pipe, Howard W. Sams Inc., 1976.
Chapter: 1.

Introduction to Electricity and Electronics. Orla Loper and Arthur Ahr,
Delmar Publishers, 1973. Chapter: 1.

Overview:

The primary purpose of this unit is to provide an introduction or initial exposure into the Electricity/Electronics area of instruction. The central theme, however, is to provoke student awareness of the nature, characteristics, magnitude, and application of electricity.

The unit lesson should concentrate on first describing that electricity is still in many ways a mystery, although, society has put it to a variety of uses.

Next, a technical presentation explaining the specific principles of both static and dynamic electricity.

Unit 1 should conclude with an emphasis on the importance of electricity and the reasons for its expanding influence and vast market of job opportunities.

This unit will not contain a formal examination as will other modules, because of the length and nature of the subject matter presented.

Suggested Presentation Hints/Methodology:

Follow the instructional module unit outline as a basic skeleton for curriculum presentation, however, note the following:

1. An important aspect of this lesson would be to stress that static electricity is largely a nuisance, a disturber, and a potentially dangerous foe in some instances. A frank discussion about lightning, its cause, and how one can avoid harm should be helpful to the student in terms of personal safety.
2. Some students are hesitant to admit that they are confused or that a concept is not clear to them. The student should be aware that in this class there is no penalty for admitting that they are technically bewildered and in need of further explanation.
3. When explaining the basic difference between static and dynamic electricity try to equate static to electrical charges "at rest" while describing dynamic electricity in relationship to electrical charges in motion to accomplish a specific purpose.
4. It is highly important as they begin their studies in this field that they realize that technical reading requires a slower pace due to the illustrations, schematics, and other graphics that must be digested. Recommend to students that when they read they concentrate on comprehension rather than reading speed.

Supplemental Activities and Demonstrations:

1. This is a sure fire attention grabber if materials are available. Obtain a static machine or Tesla coil and operate it in a manner to dramatically show the affects of static electricity. Check with the science area at your school for possible support materials.
2. Suspend a charged balloon from a stand, then bring a rubber rod that has been rubbed with cat's fur or flannel near the balloon. Observe the reaction and discuss with your class. Repeat this demonstration utilizing a glass rod rubbed with silk!!
3. With the class, itemize all the uses of electricity that they can think of and then list them on the chalkboard. From this list discuss the significance of this subject field to their daily life and the world around them.

Instructional Module Contents:

1. Unit Outline (overhead)
2. Worksheet - Awareness-Classifying Electrical Devices
3. Quest Activities

I. Introduction to the World of Electricity

A. What is Electricity?
   1. Silent, invisible, and a clean form of energy

   2. Static or nonfunctional electricity

   3. Dynamic or functional electricity

B. Why Study Electricity?
   1. Importance to modern society

   2. Applications

   3. Expansion of job opportunities

SCORE:

GRADE:

Name: ____________________

Date: ____________________

Period: ____________________

WORKSHEET

AWARENESS-CLASSIFYING ELECTRICAL DEVICES

You have probably heard many times that the world would be very different without any Electricity/Electronics devices. At home, a television set, a radio, an electrically controlled stove, a telephone, even a stereo system may contribute an importance function to our daily lives.

In this assignment you will list first, ten essential electrical devices that are very necessary for our daily existance. Next, you will list ten luxury electrical devices that may be important, but if necessary we could live without.

Electrical Device Lists

NECESSARY	LUXURY
1. ____________	1. ____________
2. ____________	2. ____________
3. ____________	3. ____________
4. ____________	4. ____________
5. ____________	5. ____________
6. ____________	6. ____________
7. ____________	7. ____________
8. ____________	8. ____________
9. ____________	9. ____________
10. ____________	10. ____________

Perhaps you found that completing these lists were more difficult than you imagined!! Some electrical devices can be both essential and a luxury device, depending on their specific use. In either case our lives are greatly influenced by the many devices created through electrical technology

TECHNOLOGY: (From two Greek words)

① Techne = skill ② logos = word/account

A technology, then, is a description about how something was made.

SCORE:

GRADE:

Name: ____________________

Date: ____________________

Period: ____________________

WORKSHEET

QUEST ACTIVITY
"UNIT 1"

In your own words write the answers to the following questions. Be neat and make complete sentences when necessary.

1. Make a list of "5" machines or appliances which use electricity and that have been recently invented, write your answers in the squares below.

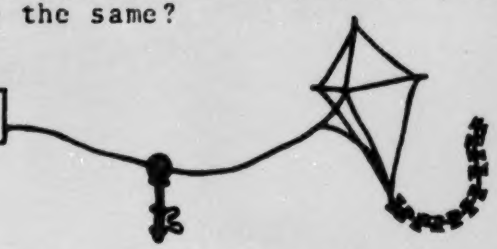
______	______	______	______	______
1	2	3	4	5

2. Describe two ways or methods of producing a charge of static electricity

______ ______ ______ ______	OR	______ ______ ______ ______

3. What is the main difference between static and dynamic electricity?

4. What is the name of the great American (1706-1790) who proved that lightning and electricity were the same?



5. Locate a standard dictionary and look up the term electricity and copy this definition in the space provided.

ELECTRICITY: ______________________________

____

____

ANSWER SHEET
UNIT 1

A. ELECTRICAL DEVICES

(subjective answer)

B. QUEST ACTIVITY

1. (subjective answer)
2. rub a glass rod with silk, move a comb through your hair, rub a rubber rod with cat fur, scuff your feet across a wool rug, wind rubbing across the surface of the earth, etc.
3. Static electricity is a high voltage charge with no electron movement and cannot be controlled. Dynamic electricity has electron movement and can be controlled to produce work.
4. Benjamin Franklin
5. (subjective answer)

ELECTRICITY / ELECTRONICS

CURRICULUM GUIDE
INSTRUCTIONAL MODULE

UNIT II
ELECTRICAL SAFETY
LEVEL II

STATE OF CALIFORNIA
DEPARTMENT OF EDUCATION

NAME____________________
DATE STARTED____________
DATE COMPLETED_________

BY
R. E. LILLO
N. S. SOFFIOTTO

STATE ELECTRICITY/ELECTRONICS CURRICULUM GUIDE
INSTRUCTOR'S GUIDE TO ACCOMPANY LEVEL II UNIT #2

Title of Unit: Electrical Safety

Time Allocation: 1 week

Unit Goal:

To inform and instil student competence in safe guarding themselves and to apply this safety attitude to their daily life, whether in the classroom, on the job, or at home.

Unit Objectives:

The student will be able to:

1. identify the three classes or categories of fires, and indicate the proper method of extinguishing each.
2. distinguish between common safe laboratory practices and, hazardous conditions, and pass a safety test with 100% accuracy, based on the information discussed.
3. explain and apply the proper safety and first aid procedures when dealing with an electrical hazard or a serious shock.

Evaluation:

The student will demonstrate his/her competence in terms of these measurable objectives based upon individual instructors acceptable performance criteria which utilizes a combination of written or oral testing procedures.

Instructor References:

Basic Electricity: Theory and Practice. Milton Kaufman and J.A. Wilson, McGraw-Hill Book Co., 1973. Appendix A.

Industrial Education Safety Guide. Published by the State of California 1978.

Making Safety Work. National Safety Council, McGraw-Hill Book Co., 1976.

Overview:

The unit should be introduced as a necessary, yet meaningful resource for all activities. In order to place "safety" in its proper perspective within the students' mind, stress that safety instruction should begin early in childhood and extend continuously throughout life! The idea that accidents or electrical shock are unaboidable in this kind of class must be discouraged.

The central safety theme of this unit is promoted by the discussion of rules which have been established to assist students in remembering the fundamentals of preventing accidents.

The next topic of emphasis deals with the nature of electrical shock and the first aid procedures to employ if necessary.

This unit concludes with a brief description of fire prevention and fire classifications. The student will also learn about proper extinguishing techniques to be used, dictated by the type of fire encountered.

Suggested Presentation Hints/Methodology:

Follow the instructional module unit outline as a basic skeleton for curriculum presentation, however, note the following.

1. This unit is often used as the most opportune time to introduce both school fire drills or civil defense drills. Try to impress students, during these kinds of activities, with the idea that disaster preparation is the only thing that really saves lives.
2. In the objectives of this unit it is stated that a safety examination must be passed with 100% accuracy, however, with some students this may be virtually impossible. Allow these few the opportunity to retake the test after a study session, but do not advertise this make up test at the beginning of the safety lesson. Sometimes certain disadvantaged students have a very difficult time to comprehend the vast amount of written material handed out, hence they score lower than other students on the test. A buddy study system will assist them greatly in achieving a successful score.
3. When describing dangerous current levels and their affect on the human body, remember that electrical terms and units of measurement may not be familiar to some students at this time, thus much of the impact will be lost if this is not considered and modified.

Supplemental Activities and Demonstrations:

1. Obtain and show a good safety film from regular film sources, local industries, National Safety Council, or any other company and/or institution which offers such a service.

2. When explaining the classification of fires, demonstrate the actual procedures necessary to activate the fire extinguisher. A blast from a chemical extinguisher while explaining operating techniques can stimulate a class instantaneously.

3. Invite a medical guest speaker to deliver a simple first aid presentation to the class. Prior to the class lesson explain to the guest specific areas of concentration that will help the overall safety program.

Instructional Module Contents:

1. Unit Outline (overhead)
2. Pre-Post Test (keyed)
3. Technical Glossary
4. Worksheet (vocabulary) - Spelling Puzzle
5. Quest Activities
6. Informational Handout (Shop Conduct and Procedure Rules)
7. Informational Handout (Classification of Fires and Extinguishing Techniques)
8. Informational Handout (Laboratory Safety Procedures)
9. Informational Handout (Electrical Shock
10. Unit Module Answer Keys

II. Electrical Safety

A. Safety-philosophy and Attitude

B. Electric Shock

C. Laboratory Conduct and Procedures

D. Safety Rules

E. First Aid Procedures

F. Fire Safety

G. Civil Defense Drills

Test Number ______

LII-U2 SAFETY

UNIT EXAM

ELECTRICAL SAFETY

IMPORTANT-
Indicate your responses on the answer sheet only. Fill in the box corresponding to the correct answer to each question - there is only one correct answer for each question.

1. "Horseplay", running, and throwing of objects are dangerous practices in the shop and are forbidden:
(A) when the teacher is looking, (B) only when students are working, (C) at all times, (D) occasionally.

2. When using machines or hand tools:
(A) give the job all your attention, (B) stand up straight, (C) watch your classmates, (D) watch the clock.

3. The floor, aisles, and passageways should be kept clear of stock, tools, and materials. Objects on the floor:
(A) may be left there if the operator of the machine is in a hurry, (B) may cause someone to slip or trip into a moving machine, (C) may be ignored, (D) are unsightly.

4. Students must not talk to or distract a person operating a machine because:
(A) the operator is likely to be injured, (B) conversation slows down the flow of work, (C) the operator is likely to make a mistake, (D) conversation is annoying to the operator.

5. Report to the teacher any:
(A) damaged tools and equipment, (B) missing guards, (C) equipment not working properly, (D) all of the above.

6. Never operate shop equipment when the teacher is:
(A) out of the shop, (B) in the shop, (C) both A and B, (D) none of the above.

7. Most tools are designed for a specific use or purpose. If they are used incorrectly, the result may be:
(A) damage to the student's project, (B) breakage of tools, (C) injury to the students, (D) damage to the bench tops.

8. Long hair is dangerous around shop equipment. If it is long enough to get caught in the machine, it must be:
(A) tied up and back, (B) burned off, (C) pulled out, (D) none of the above.

9. Loose clothing must be securely fastened or removed and long loose sleeves rolled up above the elbows:
(A) before operating any machine, (B) after operating any machine, (C) during the operation of a machine, (C) only when you are assisting the teacher.

10. All accidents and injuries, no matter how slight must be:
(A) ignored, (B) reported to the principal's secretary immediately, (C) reported to your teacher immediately, (D) reported to the shop foreman immediately.

11. Caution other students if you see a violation of shop:
(A) traffic rules, (B) good manners, (C) safety rules, (D) none of the above.

12. Only the operator and __________ are permitted within the working area around a machine.
(A) one other student, (B) the teacher, (C) a helper, (D) all of the above.

13. Gasoline, paints, kerosene, and other materials that will burn or produce fumes should be used:
(A) with another student, (B) in a well ventilated area, (C) at a workbench, (D) in an enclosed area.

14. Students are to operate only those machines or pieces of equipment for which they have received:
(A) instructions to operate, (B) permission to operate, (C) both A and B, (D) none of the above.

15. When touching electrical switches, plugs, or receptacles be sure your hands are dry because:
(A) a switch will not operate properly if your hands are wet, (B) a plug will easily slip from your fingers if your hands are wet, (C) if your hands are wet, you may receive a severe shock and serious burns, (D) none of the above.

16. Acid or chemicals on the hands or face should be immediately washed away with plenty of:
(A) water, (B) glycerine, (C) olive oil, (D) vaseline.

17. If you notice any breakage or damage to tools, instruments, or machinery, you should:
(A) repair the damage yourself, (B) be careful when using such equipment, (C) say nothing because you might get the blame, (D) none of the above.

18. Screws, nuts, and other nondigestible materials are never to be placed in your:
(A) hand, (B) pocket, (C) mouth, (D) all of the above.

19. If you are in doubt about the use of any tool or machine, or about any shop procedures:
(A) ask an advanced student for help, (B) proceed cautiously, (C) always ask your teacher, (D) none of the above.

20. Always sweep scraps from your workbench or table with a brush or whisk broom rather than your hand because:
(A) sharp or jagged particles may injure your hand, (B) less dust is stirred up, (C) this is the easiest way to clean up, (D) it will cause less work for the janitor.

21. Eye protection is used to:
(A) improve your vision, (B) prevent eyestrain, (C) prevent flying particles or corrosive substances from entering your eyes, (D) none of the above.

22. When tools are carried in the hands, keep the cutting edge or sharp points:
(A) directed toward the floor, (B) directed away from the body, (C) directed over the head, (D) directed toward the body to protect others.

23. NEVER direct compressed air:
(A) toward the floor, (B) toward the teacher, (C) toward another student, (D) all of the above.

24. Extension and power cords should always be checked and kept in good repair because:
(A) breaks and tears in the cord are unsightly, (B) breaks and tears in the cord can cause serious shocks or burns, (C) sparks may cause wood to burn, (D) a short may cause the machines to burn up.

25. Carbon dioxide (CO^2) fire extinguishers may be used to put out what types of fires?
(A) electrical fires only, (B) wood fires only, (C) oil fires only, (D) any kind of fire.

26. Water should never be used to put out what kind of fires?
(A) wood fires, (B) electrical and oil fires, (C) paper fires, (D) none of the above.

27. The proper procedure to fight a fire with a fire extinguisher is to:
(A) point the nozzle at the top of the flame, (B) point the nozzle at the middle of the flame, (C) cover the area around the fire and keep it from spreading, (D) point the nozzle at the source of the fire because that is where the fire is located.

28. In case of fire in the shop you should first:
(A) run out of the shop, (B) throw water on it, (C) sound the alarm, (D) none of the above.

29. Lifting any object that is too heavy for you:
(A) is all right if you do it slowly, (B) can be done if you know the right way to lift, (C) should never be done, because it may cause strain or rupture, (D) is a good way to show off your strength.

30. Before the power is turned on, the teacher must check:
(A) the hand tools, (B) the classroom, (C) all special setups, (D) none of the above.

31. The teacher MUST approve:
(A) all "horseplay", (B) all projects, (C) all fighting in the shop, (D) none of the above.

32. Deliberately shorting an electric circuit:
(A) is permissible if the voltage is low, (B) may damage the wires, (C) is an easy method to test whether the circuit is closed or open, (D) may cause an explosion or do bodily harm.

33. Cutting two or more "hot" wires with pliers:
(A) is safe practice if the handles of the pliers are insulated, (B) is permissible if the wires are 18 gage, (C) may be done safely if you are standing on a wooden floor, (D) none of the above.

34. Shop clean up is the responsibility of:
(A) the custodian, (B) all the students, (C) the teacher, (D) the principal.

35. When a machine makes an unusual sound, it should be:
(A) oiled immediately, (B) ignored, (C) reported to the teacher immediately, (D) adjusted.

36. Check a soldering iron for heat with:
(A) your face, (B) your hand, (C) a piece of solder, (D) your feet.

37. To remove excess solder from a soldering iron tip:
(A) wipe with a cloth, (B) flip it off, (C) wash it off, (D) use cleaning fluid.

38. When changing components in an electrical circuit:
(A) leave the plug in, (B) pull the plug out, (C) turn the circuit on its side, (D) turn off the power switch.

39. Make sure that the hand tools you are going to use are:
(A) sharp, (B) the proper tool for the job, (C) in good condition, (D) all of the above.

40. If a tool becomes defective while you are using it you should:
(A) hide it so that no one will know, (B) report the condition of the tool to the instructor, (C) place it back on the tool panel and not say anything (D) repair the tool yourself.

41. Be sure your hands are as free as possible of __________ before using hand tools.
(A) dirt, (B) grease, (C) oil, (D) all of the above.

42. Repairs are to be made on shop equipment only with:
(A) the power on, (B) the machine running, (C) the teacher's permission, (D) none of the above.

43. Spilled oil or grease is dangerous. Always:
(A) clean it up, (B) leave it, (C) pour water on it, (D) none of the above.

44. The motion involved in striking or cutting must be done in a direction:
(A) towards you, (B) away from you, (C) towards other students, (D) all of the above.

45. A project is still dangerous even after its power switch is turned off because:
(A) it may still be plugged in, (B) some of the components may be hot, (C) the capacitors can store a charge which can shock you, (D) all of the above.

46. Never use a file:
(A) without a handle, (B) as a pry bar, (C) as a hammer, (D) all of the above.

47. Pass tools to classmates:
(A) with handles first, (B) with the points first, (C) by throwing them, (D) none of the above.

48. Before starting a machine, you must:
(A) check all adjustments, (B) make sure all guards work, (C) remove all tools/rags, (D) all of the above.

49. Before leaving a machine, you must make sure:
(A) the guards are off, (B) the power is off, (C) the machine has come to a complete stop, (D) both B and C.

50. I did well on this test.
(A) True, (B) False, (C) OK, (D) I blew it.

SAFETY

Name: ____________
Date: ____________
Period: ____________

TECHNICAL GLOSSARY

ACCIDENT:	An unplanned or unexpected occurance usually resulting in injury. Most common shop accidents can be prevented by observing safety rules, working carefully, and using common sense.
ARTIFICIAL RESPIRATION:	A life saving procedure used to revive a person who has stopped breathing. Artificial respiration may be required as a result of electrical shock, drowning, strangling, etc.
CARDIAC ARREST:	A loss of heartbeat caused by electrical shock, or high blood pressure. Closed cardiac massage is the recommended first aid procedure.
ELECTRIC SHOCK:	The flow of an electric current through the body. Shock can cause such physical effects as muscle twitching or paralysis, burns, interruption of breathing, unconsciousness, ventricular fibrillation, cardiac arrest, or death.
FIRE:	A combustion process characterized by heat, flame, and light. There are three general classes of fire: Class A fires involve wood, paper, rubbish, and fabrics; Class B fires involve oil, grease, gasoline, paints, and solvents; Class C fires involve insulation and other combustible materials in electrical and electronic equipment.
FIRE EXTINGUISHER:	A portable, selfcontained device holding a liquid, or chemical which can be sprayed on a fire to extinguish it.
FIRST AID:	Emergency treatment for injury, accidents, or sudden illness generally administered before regular medical care is available.
FLAMMABLE:	A designation for types of materials which are easily ignited or set on fire. Other designations may be used to identify these materials, such as; combustible or inflammable.
GROUNDING:	A safety precaution which calls for placing the metal housing or case of a device at ground potential to prevent possible operator shock. Most commonly, a third wire is added to the power cord. This wire is connected between the case and earth ground allowing an alternate path for current flow. Thus, if the metal housing of a device becomes electrically "hot", current will flow through the grounding wire to the earth, instead of through the operators body to earth.

Name: ____________

Date: ____________

Period: ____________

HAND TOOLS:	This term refers to a wide variety of tools which require physical manipulation or primarily the use of your arms and hand muscles for their operation and use. Examples of typical hand tools would be; screwdrivers, wrenches, soldering irons, pliers, etc..
HAZARD:	The presence of a dangerous or potentially dangerous situation.
HORSEPLAY:	The undesired, potentially hazardous, activity of clowning or playing in the shop or laboratory.
INJURY:	Physical harm or damage to ones body.
LIVE CIRCUIT:	An electrical circuit which is energized, (power applied switch on) and capable of producing current flow.
MACHINE TOOLS:	Generally, power assisted tools utilized for "heavy" jobs which require work beyond that supplied by hand tools. Examples of machine tools; drill press, grinders, sheet metal shears, box and pan break, etc..
SAFETY GLASSES:	Protective eye glasses with shatter proof lenses and side shields. Safety glasses should be worn at all times when necessary while working in the shop. They provide invaluable protection by preventing foreign materials (pieces of wire, chips, broken glass, chemicals etc.) from entering or coming in contact with the eyes. Goggles and face shields can be utilized to provide additional eye protection while working in extremely hazardous areas.
SAFETY PRECAUTION:	An action taken, followed or observed, to avoid a possible hazard or dangerous situation.
SAFETY RULES:	A specific list of rules designed to identify common accident causing situations and hazards. By observing the safety rules many accidents will be avoided or prevented.
VENTRICULAR FIBRILLATION:	A type of heart failure, caused by electric shock, in which the heart muscle no longer beats in a regular fashion but rather quivers erratically. If this condition is not corrected rapidly, death will result.

SCORE:

GRADE:

SAFETY

Name: ____________

Date: ____________

Period: ____________

WORKSHEET

VOCABULARY - SPELLING PUZZLE

Copy the correctly spelled word in the box to the right as indicated in the example below.

A. (sampel) (sample) (sampal) A. sample

1. (flameable) (flammabel) (flammable) 1. ☐

2. (extinguisher) (exstinguisher) (estingwisher) 2. ☐

3. (axsident) (accedent) (accident) 3. ☐

4. (hasard) (hazard) (hazhard) 4. ☐

5. (safety) (safty) (saftey) 5. ☐

6. (percaution) (precausion) (precaution) 6. ☐

7. (injery) (injury) (ingery) 7. ☐

8. (sock) (shoch) (shock) 8. ☐

9. (first aid) (first aide) (firstaid) 9. ☐

10. (fibillation) (fibulation) (fibrillation) 10. ☐

11. (groundin) (grounding) (grownding) 11. ☐

12. (resperation) (resperasion) (respiration) 12. ☐

13. (machine) (mashene) (mechine) 13. ☐

14. (cercut) (sircut) (circuit) 14. ☐

15. (horesplay) (horseplay) (horspla) 15. ☐

SCORE:

GRADE:

Name: ______________

Date: ______________

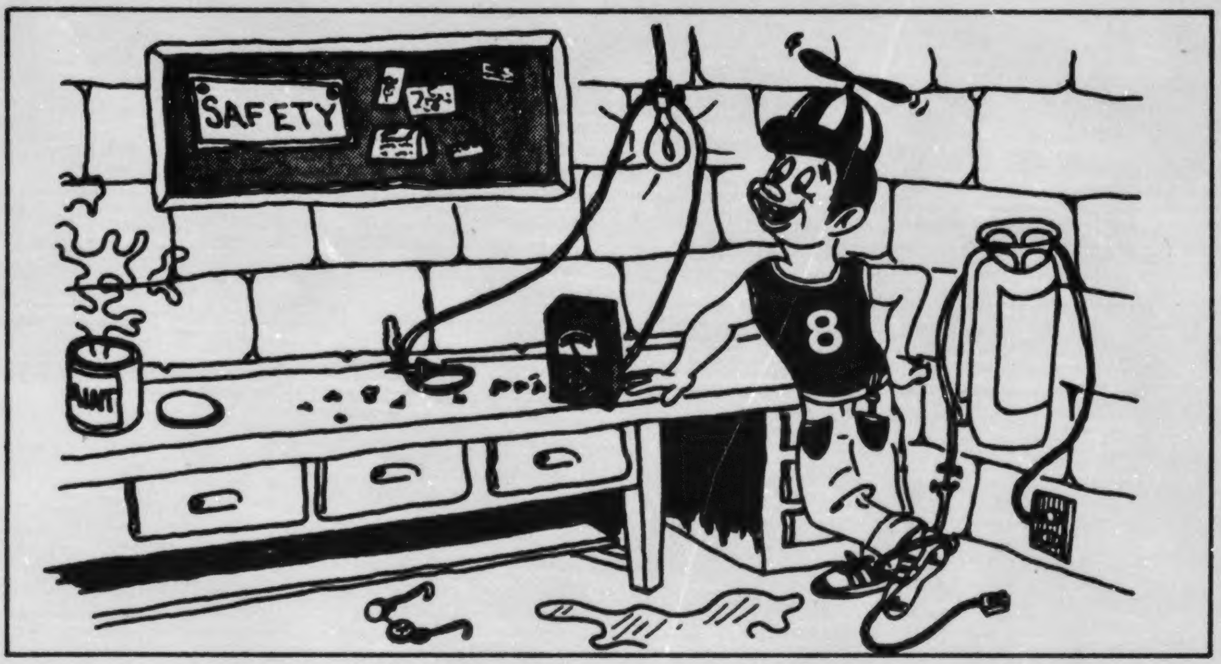
Period: ______________

SAFETY

WORKSHEET

QUEST ACTIVITY

"UNIT 2"



Carefully study the diagram above, and locate at least 10 safety violations. List your findings in the spaces below. If you are a true safety sleuth you should be able to find 13 problems.

1. ______________

2. ______________

3. ______________

4. ______________

5. ______________

6. ______________

7. ______________

8. ______________

9. ______________

10. ______________

11. ______________

12. ______________

13. ______________

GREAT JOB!

SAFETY

Name: ____________________

Date: ____________________

Period: ____________________

INFORMATIONAL HANDOUT

SHOP CONDUCT AND PROCEDURE RULES

1. Students must be on time daily and each student must be in his/her assigned seat before the tardy bell rings.
2. You are required to have a notebook specifically for this subject at your desk each day. It will be collected and graded during the year.
3. You must also supply yourself with the necessary materials for classroom notes - paper and a writing tool.
4. All handouts and notes will be kept neatly in your notebook, not scattered in your locker.
5. Seats (and lab. station) will be assigned. Do not change your seat without consulting your teacher.
6. Absolutely no horseplay in the shop. Many painful accidents occur by the careless and thoughtless antics of the so-called "clown." Walk in the shop at all times. Loud talk and unnecessary noise will not be tolerated.
7. No eating, drinking, or gum chewing is allowed in the shop or classroom.
8. Keep your desk (lab. station) and adjacent floor area clean.
9. Pencils should be sharpened before class. All trash (scratch paper etc.) shall be kept at your desk and thrown away after class only.
10. Throwing anything in the classroom is absolutely forbidden.
11. Turn in all assignments on time. Late assignments will be down graded.
12. If you finish your work before others, use the extra time constructively. Do not disturb your fellow students.
13. Poor attendance will hurt your grade, because it is difficult to make up missed work.
14. It is the students responsibility to make up any tests or missed work.
15. Feel free to ask questions anytime on subject matter which you do not understand.
16. If you must leave the room during class, clear it through the instructor first.

Name: ______________________

Date: ______________________

Period: ______________________

17. Work safely and encourage other students to do the same by setting a good example each day.

18. Use only the machines and tools for which you have satisfactorily passed safety tests.

19. Report any injuries or damage to yourself or equipment to the teacher.

20. Malicious damage to equipment and parts will not be tolerated. You will be required to pay for any damage caused in this manner.

21. Do not remove any project, or material, from the shop without the instructors approval.

22. When the time for clean-up comes, cooperate with the foreman and do your fair share to keep the shop clean and attractive.

23. Students must return to their seats prior to class dismissal at the end of the period. Class will be dismissed only after the shop is clean, all tools are accounted for, and all students are quiet and in their assigned seats.

SHOP CONDUCT AND PROCEDURE RULES

The shop conduct and procedure rules have been read and explained to me. I agree to abide by these rules, and if I have any questions I will ask the instructor.

Students signature: ______________________

Period: ______________________

Date: ______________________

Instructors initial: ______________________

SAFETY

Name: ____________________

Date: ____________________

Period: ____________________

INFORMATIONAL HANDOUT

CLASSIFICATION OF FIRES AND EXTINGUISHING TECHNIQUES

There are three classification categories for fire. Each type of fire requires special extinguishing techniques. Use the chart below to distinguish the extinguishing techniques.

Class "A"

Fires involving combustible material such as wood, paper or cloth: to extinguish, cool and quench with pump type extinguishers containing water, or soda-acid. CO^2 (carbon dioxide) extinguishers may also be used.

Class "B"

Fires involving flammable liquids such as gasoline, kerosene, greases, thinners, and finishes: smother the burning fuel. Foam and CO^2 type extinguishers may be used.

Class "C"

Fires involving electrical equipment; use a nonconducting type extinguisher such as CO^2 or dry powder, and if possible disconnect the source of electrical energy.

NOTE: Always point the fire extinguisher nozzle at the source of the fire and not at the top of the flame.

SAFETY

Name: ____________________

Date: ____________________

Period: ____________________

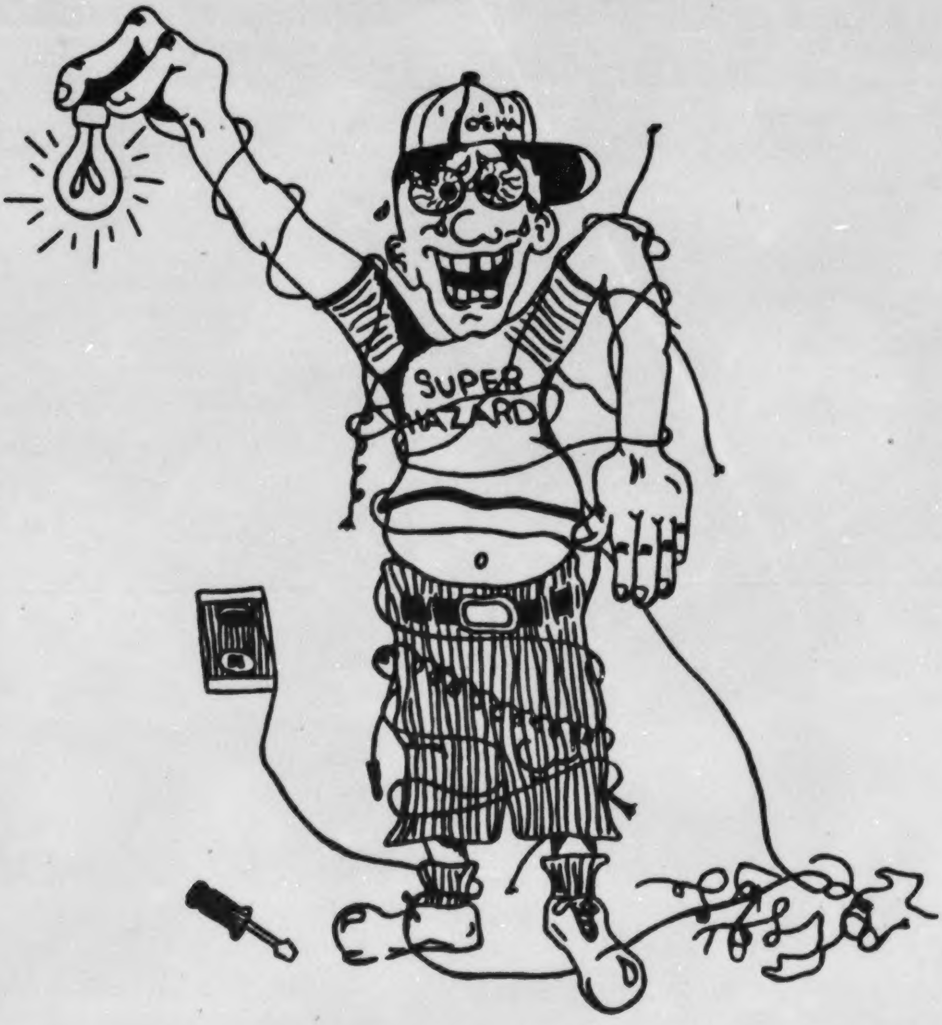
INFORMATIONAL HANDOUT

LABORATORY SAFETY PROCEDURES

INTRODUCTION:

People working in industry know the importance of safe working habits. Safety training programs are sponsored by unions, management, public agencies, and insurance companies. Despite these good efforts, accidents annually cause lost job time, painful injuries, and needless deaths.

Good safety habits are learned daily. As you begin your laboratory work in electricity, resolve now to learn and practice safe working habits in the laboratory. The choice of your future safety and future laboratory work habits is up to you. Form safe habits now.



Name: ____________________

Date: ____________________

Period: ____________________

GENERAL SAFETY PROCEDURES:

Safe Attitudes. Laboratories are working areas for adults. Tricks, games, and horseplay should be left in the school yard.

Safe Environment. Work areas must have proper power, ventilation, and light. Aisles should be open and clear. Storage areas are to be kept clean and secured. The use of temporary extension cords, fans, heaters, gas or water connections is discouraged. Maintain a neat and orderly work area.

First Aid Procedures. Even with good safety practices someone may be injured. Your instructor and/or the school nurse are trained in first aid procedures, but there are several general rules which you should follow.

Don't panic! Determine if there is any immediate danger to the injured person. Never move an unconscious person without cause. Lay such a person flat. Keep the person warm to prevent shock. Never try to force liquids on an unconscious person. If the victim is breathing normally, keep the person still and comfortable until medical aid arrives.

Severe electrical shock or other types of accidents may interrupt breathing. A procedure such as artificial respiration can be used to stimulate the breathing process. Check for a swallowed tongue before application of artificial respiration. This procedure should be administered by a trained person if possible, and continued until medical help arrives. The two common methods of artificial respiration are mouth-to-mouth and the Schaeffer method.

All injuries should be reported to the instructor. Even minor cuts can become infected, and the best first aid supplies, nurses, and doctors cannot help an unreported injury.

Name: ____________________

Date: ____________________

Period: ____________________

GENERAL SAFETY RULES:

Shop Behavior and Safety Practices

1. Clowning, scuffling, pushing, running, and throwing objects are dangerous practices in any shop and are forbidden at all times.

2. Obey all warning signs--they are posted for your protection.

3. Caution any student you see violating a safety rule.

4. When using machines or hand tools, give the job at hand all of your attention.

5. Work at a speed consistent with safety. "Foolish hurry," such as rushing to complete a procedure, is dangerous.

6. Cooperate with your classmates in the shop cleanup program.

7. Machines must not be operated while instructor is out of the room.

8. If equipment is not working properly, shut it off and tell the instructor at once.

9. Report to the teacher all breakage or damage to tools, machinery, or equipment.

10. A student who sees a dangerous situation must report it at once to the teacher.

Eye Protection

11. Eye protection must be worn when working in an area where hazardous conditions exist.

12. Face shields or goggles shall be utilized where extra protection is required, such as while grinding or working with caustic substances.

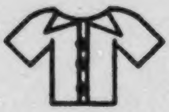
13. Eye glasses must not be used in place of goggles or face shields.

14. When compressed air is used for cleaning, wear eye protection. Take care to direct chips, shavings, and dust away from other students. NEVER ALLOW THE STREAM OF AIR TO COME IN CONTACT WITH YOUR BODY.

Name: ____________________

Date: ____________________

Period: ____________________



Clothing

15. Wear safe clothing when working in a shop. Fasten or remove loose clothing before you operate any machine. Roll long sleeves above the elbows. Apron fastening should be such that they will break if the apron becomes entangled in a machine.

16. Long, loose locks of hair can easily be caught in revolving machinery and ripped out causing serious scalp laceration. Have your hair cut short, tied back, or tightly covered.

17. Wearing gloves is forbidden when you are working with power driven machinery in the lab.

18. Remove jewelry--bracelets, rings, chains, and other accessories that are hazardous in shop work.

19. Sharp, pointed tools or materials are not to be carried in clothing. Hold sharp pointed edges down.

20. Always wear protective clothing when working with chemicals. Rubber gloves should be worn when handling chemicals or immersing your hands in chemical solutions.

21. Always wash hands with soap and water after working with materials that might be harmful to the skin.

Housekeeping

22. Keep your work area clean and orderly. Good housekeeping is part of safety.

23. Keep floors, aisles, and passageways clear of materials and equipment.

24. Keep tools in a safe place. Never leave them where they may cause injury. Put them in tool boxes, trays, cases, or on wall panels.

25. Store material neatly and securely and in a place where persons passing will not be injured.

26. If water, grease or oil is spilled on the floor, clean it up immediately to prevent slipping.

27. Extension cords shall always lie flat on the floor in such a way that students will not trip over them.

28. Always use a brush to clean off benches and machines. There may be sharp or jagged particles among the scraps, which could cause serious injury to the hands.

Name: ____________________

Date: ____________________

Period: ____________________

29. Always keep bench, cabinet drawers, and locker doors closed.

30. Keep tools and materials from projecting over the edge of benches or tables whenever possible.

OK Approval

31. Students are warned not to use machines until they have been given the proper safety instruction, and received permission from the teacher. The student must ask for further instructions if in doubt concerning any operation.

32. When in doubt, ask the instructor. Do not depend upon the advice of another student.

33. The shop safety test must be passed by students in order to operate any power driven machine.

34. Do not operate switches of machines and instruments unless given permission to use them by the instructor.

35. Ask your instructor to approve all projects you plan to do.

36. Repairs are to be made on shop equipment only when permission has been given. Do not tamper with shop equipment.

37. All special set-ups in the lab. must be approved before the power is turned on.

✚ Injury

38. Report all accidents, however slight, to the instructor at once. Infection may result from uncared for cuts and scratches.

39. When lifting heavy objects, keep your arms and back as straight as possible, bend your knees, then lift with the powerful muscles in your legs.

40. Do not attempt to lift heavy items alone. If there is any doubt in your mind about your ability to safely lift an object, ask for help.

41. Screws, nuts, and other nondigestible materials are never to be placed in one's mouth.

Name: ______________________

Date: ______________________

Period: ______________________

Fire

42. The location of fire extinguishers, fire exits, and fire drill procedures shall be known by all students.

43. Nothing shall be hung on fire extinguishers. The area around them must be kept clear so that they may be reached without delay if a fire were to occur.

44. When pouring flammable liquids, be careful not to spill them.

45. Oily or paint-filled rags must be placed in a covered metal container.

46. Toxic chemicals, kerosene, paints, thinners, and other finishes or cleaning materials are to be used in a well ventilated room. They are never to be used near an open flame.

47. Never use water to put out an electrical or oil fire, it will cause the fire to spread.

48. In case of fire in the shop: Sound the alarm; FIRE!!, turn off all gas and electricity, put the fire out.

Hand Tools

49. Be sure your hands are as free as possible of dirt, grease, and oil when using tools.

50. Select the right tool for the job to be done. Use the proper type and size hand tool for the job.

51. Make sure when using a sharp-edged tool to point the edge away from yourself and classmates.

52. When carrying tools in the hands, keep the cutting edge or point directed toward the floor.

53. Clamp small work on a bench or in a vise when using a hacksaw, a screwdriver, or when performing delicate operations.

54. Never use a chisel, punch, or hammer with a "mushroomed" head. Chips may fly off and injure someone.

55. Never use a file without a handle. Be sure that the handle is properly secured to the file.

56. Pass tools to classmates with the handles first.

Name: ____________________

Date: ____________________

Period: ____________________

57. Plastic handled screwdrivers should not be used near an open flame or near hot soldering irons.

58. Metal rules should be kept clear of electrical circuits. When in doubt use a plastic or wood rule.

59. All portable electric tools and equipment must be disconnected when not in use.

60. When disconnecting an electric tool or appliance from a circuit, remove the attachment plug from the receptacle by pulling on the plug handle instead of on the cord.

61. There is a right and a safe method to use all tools. Don't try to cut corners by using incorrect methods.

Soldering

62. Never test the heat of a soldering iron by feeling it with your hands. Check the heat of the iron with a piece of solder.

63. Always return the iron to its proper holder.

64. Always wipe off excessive molten solder. Never flip it off. Molten solder inflicts painful burns when it comes in contact with the skin.

65. When passing a soldering iron to another student, place it on the soldering iron rest. The other student can then pick up the iron by the handle.

66. Care must be taken not to let the soldering iron burn any electrical cord, or circuit wire.

Machine Tools

67. Only the operator may start and stop a machine, and after the machine is turned off, s/he should stand by until it has stopped running.

68. All adjustments must be securely fastened before the power is turned on.

69. All wrenches and other tools must be removed from the machine before the power is turned on.

70. Keep machine and safety guards in proper position at all times.

71. Overloading or forcing in any manner any hand operated or power driven machine is dangerous. Use only the material or stock furnished or approved by your teacher.

Name: ____________________

Date: ____________________

Period: ____________________

72. Keep rags away from machines that are in operation.

73. Make sure everyone is clear of the machine before starting it.

74. Have the instructor check all special set-ups and new operations before turning on the machine.

75. Think about your job while operating a machine. It is dangerous to talk when you are using power equipment.

76. Have machine at a dead stop, power off, before cleaning, oiling or repairing. Always turn the power off before leaving a machine.

77. Use only electric power tools that are grounded, or that have UL approved housings.

Safety Zones

78. Only the operator and teacher are permitted within the defined working area around any machine.

79. Do not lean on machines - stand clear.

80. Disturbing another student while he is working is a dangerous practice.

Electrical

81. Consider every electric circuit live until proved otherwise.

82. Make certain your hands are completely dry before touching electrical switches, plugs, or receptacles.

83. Remember even 110 volts can be fatal. Approach all jobs with caution, and analyze each job before you start.

84. The location of emergency power switches shall be known by all students.

85. Never allow anyone to turn power on and off for you while you are working with instruments.

86. Cutting two or more wires at the same time with pliers or other tools is extremely dangerous and may result in damage to the circuit and tools and severe injury to the person if the power is not turned off.

87. Electricity has no respect for ignorance. Do not apply voltage or turn on any device until it has been properly checked by the instructor.

Name: ____________________

Date: ____________________

Period: ____________________

88. Always stand a safe distance from any project when it is turned on for the first time. Sparks and smoke can be dangerous.

89. Deliberately shorting any electric circuit or generating device may damage the equipment, cause an explosion, or do bodily harm.

90. Certain components such as resistors and vacuum tubes get hot while operating. Wait for them to cool before attempting to remove them.

91. Do not work around electrical equipment if floors are damp or wet.

92. Do not work on an electrical circuit with the power turned on.

93. Be sure equipment is in proper working order before using. Frayed cords and plugs are a major source of accidents.

94. Ask for instructions before using any piece of electronic test equipment. One wrong connection can destroy an instrument and thus deprive you and others of its use until repaired. The repairs can be expensive.

95. Use proper instruments for testing circuits.

96. Before replacing a fuse in any electrical equipment, disconnect the power source.

97. When making temporary or permanent connections, carefully avoid leaving open splices or pieces of wire sticking out. Secure all wires properly. Tape or cover the connections.

- -

LABORATORY SAFETY PROCEDURES

The laboratory safety procedures have been read and explained to me. I agree to abide by these rules, and if I have any questions I will ask the instructor.

Students Signature: ____________________

Period: ____________________

Date: ____________________

Instructors Initial: ____________________

SAFETY

Name: ____________________

Date: ____________________

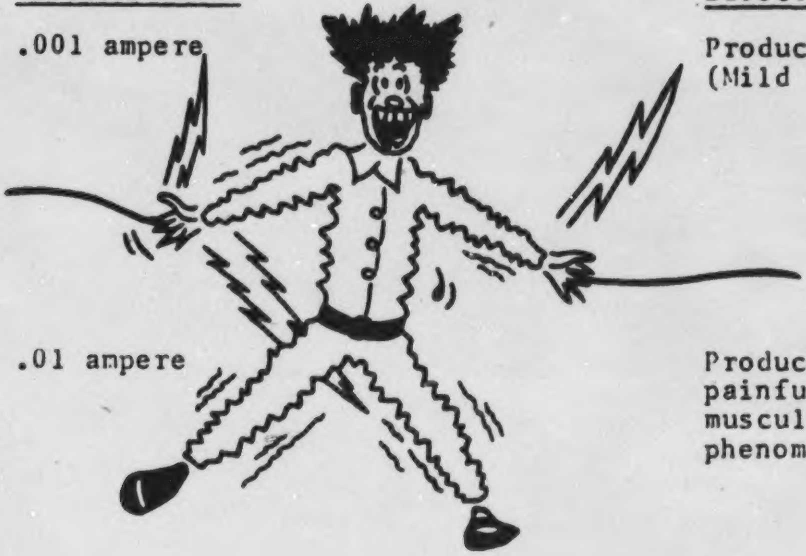
Period: ____________________

INFORMATIONAL HANDOUT

ELECTRICAL SHOCK

One of the major hazards in the electronics field is protection against electrical shock. Shock is caused by the passing of electric current through the body. Current flow is related to the voltage applied and therefore the higher the voltage the more serious the shock. Don't however get the idea that low voltages do not shock for they certainly do if the circumstances are right.

Let's see what can happen when an electric current passes through your body. A number of effects may occur depending upon the circumstances and magnitude of the shock.



Current Value	Effect
.001 ampere	Produces a shock than can be felt. (Mild "tingling" sensation).
.01 ampere	Produces a severe shock, which is painfull, and can cause loss of muscular control. (Can't let go phenomenon).
.1 ampere	Produces a potentially fatal shock which can cause death if current lasts for a second or more.

Rest in Peace
M.E. FRY

Name: ____________________

Date: ____________________

Period: ____________________

As you can see, the body is sensitive to relatively small current flows. As a comparison, a common 100 watt light bulb draws a current flow of .85 amperes, far higher than the .1 ampere of current which can cause death.

OTHER EFFECTS OF ELECTRIC SHOCK:

Muscular Paralysis-

Burns-

Cessation of breathing-

Unconsciousness-

Ventricular fibrillation-

Cardiac arrest-

All of these effects do not occur with every shock. As stated before, conditions vary. What happens to you depends upon several factors:

(1) The intensity of the current.
(2) The frequency of the current.
(3) The path the current follows through the body.
(4) How long the current passed through the body?
(5) Did you expect to be shocked?

Keep in mind, that the current flow through your body, not the amount of voltage applied is the determining factor in the severity of a shock you might receive. The higher the current, the more dangerous the shock.

CAUTION: Electric shock can be harzardous to your health.

SCORE:

GRADE:

Name: ____________

Date: ____________

Period: ____________

ANSWER SHEET

EXAM LII U2

	T	F				T	F				T	F				T	F		
	A	B	C	D		A	B	C	D		A	B	C	D		A	B	C	D
1.			■		26.		■			51.					76.				
2.	■				27.				■	52.					77.				
3.		■			28.			■		53.					78.				
4.	■				29.			■		54.					79.				
5.				■	30.			■		55.					80.				
6.	■				31.		■			56.					81.				
7.			■		32.				■	57.					82.				
8.	■				33.				■	58.					83.				
9.	■				34.		■			59.					84.				
10.			■		35.			■		60.					85.				
11.			■		36.			■		61.					86.				
12.		■			37.	■				62.					87.				
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14.			■		39.				■	64.					89.				
15.			■		40.		■			65.					90.				
16.	■				41.				■	66.					91.				
17.				■	42.			■		67.					92.				
18.			■		43.	■				68.					93.				
19.			■		44.		■			69.					94.				
20.	■				45.				■	70.					95.				
21.			■		46.				■	71.					96.				
22.	■				47.	■				72.					97.				
23.				■	48.				■	73.					98.				
24.		■			49.				■	74.					99.				
25.				■	50.					75.					100.				

*Show work for problems on back of answer sheet.

ANSWER KEY
UNIT 2

A. SPELLING PUZZLE

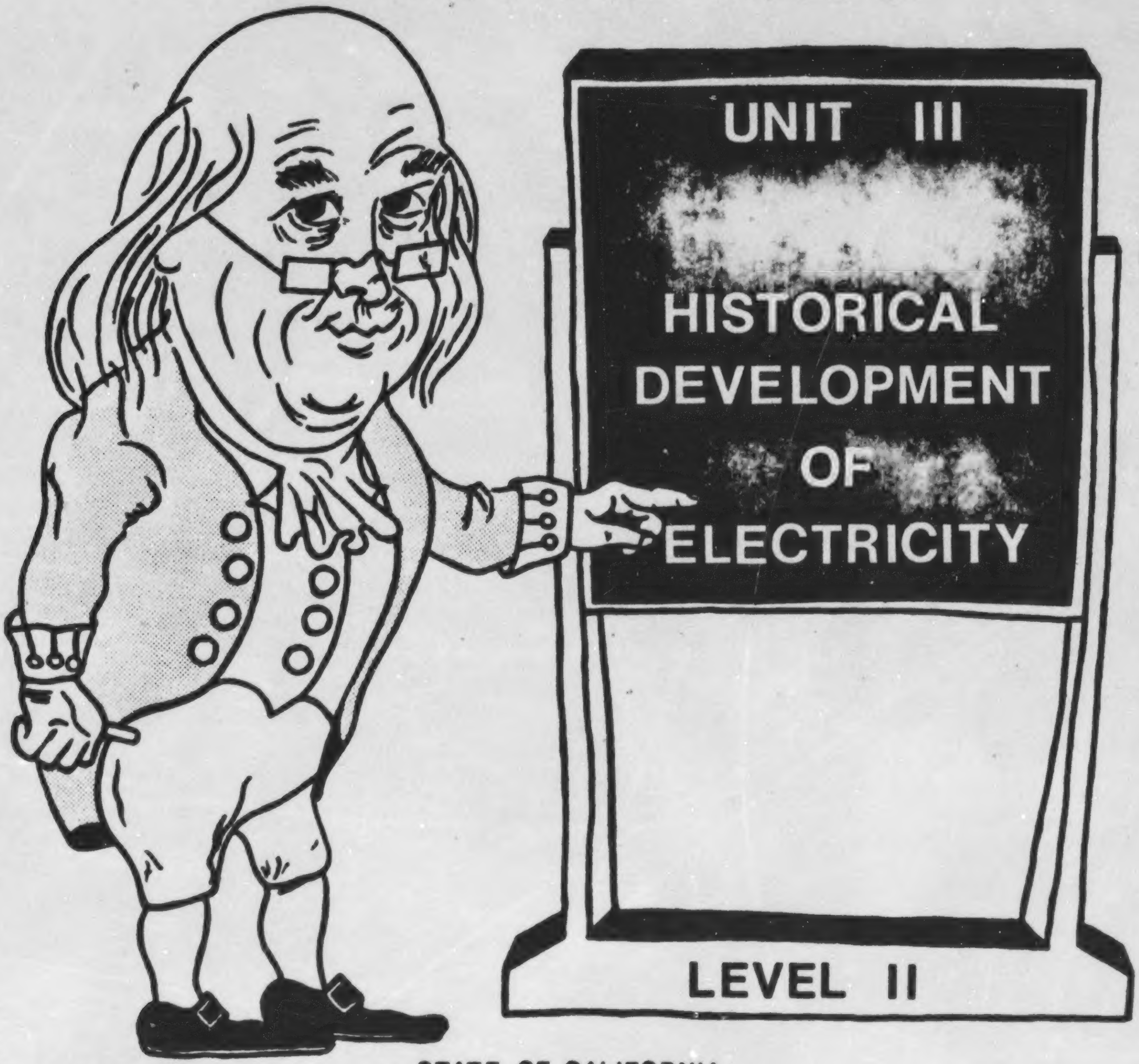
1. flammable
2. extinguisher
3. accident
4. hazard
5. safety
6. precaution
7. injury
8. shock
9. first aid
10. fibrillation
11. grounding
12. respiration
13. machine
14. circuit
15. horseplay

B. QUEST ACTIVITY

1. soldering iron is lying on its cord.
2. extension cord is wrapped around foot.
3. liquid spilled on the floor.
4. the meter is ready to fall off the bench.
5. the extension cord is hanging on the fire extinguisher.
6. a pair of safety glasses have been left on the floor and stepped on.
7. fumes from the uncovered can may ignite.
8. the extension cord is frayed.
9. there are foreign objects on the bench.
10. a tool carried in the pocket.
11. the power for the meter and soldering iron is in an awkward place and causing a possible overload.
12. the incandescent lamp is exposed.
13. the wall outlet is the two terminal type rather than desireable three terminal.

ELECTRICITY / ELECTRONICS

CURRICULUM GUIDE
INSTRUCTIONAL MODULE


UNIT III
HISTORICAL DEVELOPMENT OF ELECTRICITY
LEVEL II

STATE OF CALIFORNIA
DEPARTMENT OF EDUCATION

NAME____________________
DATE STARTED_____________
DATE COMPLETED_________

BY
R. E. LILLO
N. S. SOFFIOTTO

STATE ELECTRICITY/ELECTRONICS CURRICULUM GUIDE
INSTRUCTOR'S GUIDE TO ACCOMPANY LEVEL II UNIT #3

Title of Unit: Historical Development of Electricity

Time Allocation: 1 week

Unit Goal:

To impart basic knowledge and competencies related to the historical development of the Electricity/Electronics field and to assess the impact of these developments.

Unit Objectives:

The student will be able to:

1. state the word origin of the terms electron, electrics, or electricity.
2. identify the most significant centuries in reference to electrical discoveries and their contribution to the overall field of Electricity/Electronics.
3. select five historical figures described in this unit and explain their specific invention and/or theory which has distinguished their life.

Evaluation:

The student will demonstrate his/her competence in terms of these measurable objectives based upon individual instructors acceptable performance criteria, which utilizes a combination of written, oral, and laboratory testing procedures.

Instructor References:

American Science and Invention. Mitchell Wilson, Bonanza Books, 1960. All

Basic Electricity. Rufus P. Turner, Holt, Rinehart, and Winston, 1963. Chapter: 1.

Introduction to Electronics. Clyde N. Herrick and Bill R. Deem, Goodyear Publishing Co., 1973. Chapter: 1.

Overview:

Unit 3 is presented as a non-technical unit of instruction, however, there are many basic competencies that the student will acquire through their unit work.

The unit should be introduced with a historical description of man's first experiences with electrical phenomena. Then briefly make reference to Thales's discovery and its relationship with the present day terminology The instructor will then have to explain that for several hundred years very little significant electrical discoveries took place.

The unit should continue with a chronology of developments including historical figures, inventions and theories. This time frame of developments should conclude with a short description of "state of the art" technical discoveries of modern society.

Unit 3 ultimately is concerned in exposing the roots of this area, and giving credit to those who have planted the seeds of technology.

Suggested Presentation Hints/Methodology:

Follow the instructional module unit outline as a basic skeleton for curriculum presentation, however, note the following:

1. In addition to normal classroom activities, have students research a specific historical figure and develop a biographical sketch of the individuals life. If available use the school library, or if this is not practical the students may research their report utilizing an encyclopedia.
2. When introducing this unit give examples of static electricity, then use the chalkboard as a vehicle to explain the basic historical chronology that has occured in this field. Draw a horizontal line on the board, then on the far left hand side place the date 600 B.C. (Thales discovery). As historical events took place, record the year and other significant data and when the presentation is concluded the student will have a calendar which will assist in the comprehension of the historical sequence of technical developments.
3. A reliable resource for historical background materials can be found in back issues of many electronic magazines. Usually they are characterized by several pages of information and historical pictures. A brief synopsis of these articles makes a wonderfully informative handout for students.

Supplemental Activities and Demonstrations:

1. Check whatever audio/visual resource system that is available for materials that could coordinate with this unit topic. Especially be on the look out for films pertaining to Edison, Bell, Faraday, Morse, and Ohm. Many of these historical film biographies are classics and well worth showing.
2. To emphasize the technological advancements that have occured, compare and contrast a simple crystal radio to a modern radio. Then, draw the schematic of a crystal radio on the board and in general terms explain how it functions. Ask a student to build a working model, and if the craftmanship is super, mount the unit on a frame to be utilized as a demonstrator for future classes.
3. Check with the local telephone company and find out if they have some visuals in reference to the development of the telephone.

Instructional Module Contents:

1. Unit Outline (overhead)
2. Pre-Post Test (keyed)
3. Technical Glossary
4. Worksheet (vocabulary) - Know Your Definitions
5. Quest Activities
6. Informational Handout (Time Line of Electronics History)
7. Unit Module Answer Keys

III. Historical Development of Electricity

A. Word Origin of Electricity

B. Historical Figures and Inventors

C. Basic Chronological Development

UNIT EXAM

Match the historical individual with his/her discovery or invention.

1. Thales of Miletus
2. Stephen Gray
3. Alessandro Volta
4. Michael Faraday
5. Georg Simon Ohm
6. Samuel Morse
7. Alexander Graham Bell
8. Thomas Edison
9. Heinrich Hertz
10. Guglielmo Marconi
11. Dr. Lee de Forest
12. Col. William Blair
13. John Bardeen, Walter Brattain, and William Shockley
14. Jack Kilby
15. Ted Hoff

A. $E = I \times R$

B. Radar

C. Battery

D. Incandescent lamp

E. Integrated circuit

F. Static electricity

G. Audion tube

H. Telegraph

I. Electricity can be transmitted

J. Produced electromagnetic waves

K. Telephone

L. Transistor

M. Generator

N. Microprocessor

O. Wireless communication

1. ☐
2. ☐
3. ☐
4. ☐
5. ☐
6. ☐
7. ☐
8. ☐
9. ☐
10. ☐
11. ☐
12. ☐
13. ☐
14. ☐
15. ☐

Name: ____________________

Date: ____________________

Period: ____________________

TECHNICAL GLOSSARY

AMBER:	A brownish-yellow fossil resin. Thales of Miletus Greece, found in 600 B.C., that amber took on a mysterious charge if rubbed with cloth or other materials. Today we know this phenomenon as static electricity. Interestingly, the Greek word for amber was "elektron," which later evolved into the words "electrics" and "electricity."
DYNAMIC ELECTRICITY:	A usable or functional flow of electricity. Dynamic electricity provides a continuous flow of electrons which can be used to do work.
ELECTRICITY:	A form of energy, (generated by friction, induction, or chemical reaction) whose origin is based upon the movement of free electrons.
ELECTRICS:	A term coined by William Gilbert to identify materials that behave in a similar manner to Thales' amber - that is, materials that develop a charge when rubbed with cloth or other materials.
ELECTRONICS:	The study of electrical action, and especially the study and development of devices and circuits (resistors, transistor, etc.) that use and control electricity.
HISTORICAL DEVELOPMENT:	The identification of an important development or invention, and showing that development in proper "date" order (chronology) compared to other inventions.
STATIC ELECTRICITY:	A collection of electrical charges at rest. Static charges are basically an unusable source of electricity for power purposes.

Static : At rest

SCORE:

GRADE:

Name:

Date:

Period:

WORKSHEET

VOCABULARY - KNOW YOUR DEFINITIONS

Develop a short definition, using your own words, for the following terms.

1. ELECTRICITY:

2. ELECTRON:

3. ELECTRONICS:

4. AMBER:

5. STATIC ELECTRICITY:

6. DYNAMIC ELECTRICITY:

SCORE:

GRADE:

Name: ____________

Date: ____________

Period: ____________

WORKSHEET

QUEST ACTIVITY

"UNIT 3"

Develop a short one page biographical sketch for one of the individuals identified on the "timeline of electronics history." Use the outline form listed below to organize and simplify your work. Turn in a neat, accurate, well worded report.

Name: ____________

Date: ____________

Period: ____________

BIOGRAPHICAL SKETCH OF

____

1. Name of historical individual.
2. Year of birth - year of death.
3. Important discoveries or inventions along with date of discovery. (Ex. Transistor - 1947)
4. Location where these discoveries were made? (city or company)
5. A short paragraph describing the individuals life history.
6. Bibliography (list of references used) title of book used, author, publisher, year of publication, and page numbers.

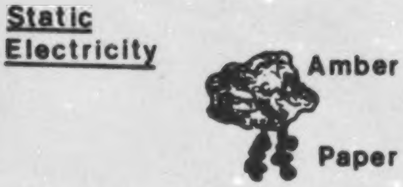
Date: ____________________

Period: ____________________

INFORMATIONAL HANDOUT

TIME LINE OF ELECTRONICS HISTORY

THE RECORD BEGINS IN GREECE:



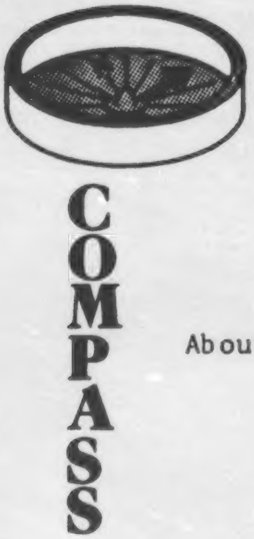
600 B.C.-- Thales, a statesman and philosopher discovered a curious attractive force between small bits of material, and a material called "elektron" (amber) that had been rubbed with cloth. Today we call this phenomenon static electricity.

SEVERAL HUNDRED YEARS LATER:

426 A.D.-- Saint Augustine distinguishes between electricity and magnetism.

ABOUT A THOUSAND YEARS PASS THEN:

1200 A.D.-- Compass first used for navigation by the Vikings. The crude device consisted of a piece of loadstone, placed on a small board, floating in a pail of water.



1600 A.D.-- William Gilbert, English physician to Queen Elizabeth discovered other materials that possessed similar properties as Thales elektron materials. He called these materials Electrics. Gilbert developed the electroscope, an instrument used for detecting an electrical charge. Gilbert's work was highlighted with the publication of the first scientific study of magnetism - "de magnete."

About 1660 A.D.-- Otto Von Guericke invented the first static electric generator - a machine which produced static electricity by friction between a rotating sulphur ball and the body.

1675 A.D.-- Sir Isaac Newton, in England, discovered electrostatic induction. The effect of static charges can be felt or transmitted over a distance.

THE EIGHTEENTH CENTURY - AGE OF BASIC DISCOVERIES:

1729 A.D.-- Stephen Gray distinguishes between conductors and insulators. He also makes the important discovery that electricity can be transmitted.

Name: ____________________

Date: ____________________

Period: ____________________

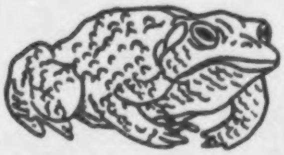
1733 A.D.-- Charles DuFay shows that there are two kinds of electricity which he called vitreous and resinous. Today we know these as positive and negative.

1745 A.D.-- E.G. von Kleist and Pieter Van Musschenbroek independently developed a device for storing electric charges - the "Leyden Jar." The Leyden Jar was the predecessor to the modern capacitor.

1746 A.D.-- Gralath built an electrometer, the first instrument for measuring electricity.

1752 A.D.-- In America, Ben Franklin performed his famous kite experiment to prove electricity and lightning are similar.

1785 A.D.-- Charles Coulomb, in France, proved the law of inverse squares in connection with electricity and magnetism.



1786 A.D.-- Luigi Galvani noticed that frog legs contracted when touched by two connected dissimilar metals. This was the modest beginning of the electric battery.

1799 A.D.-- Alessandro Volta, an Italian professor, develops the voltaic pile, the first primary battery.

THE NINETEENTH CENTURY - THE "GOLDEN AGE" OF ELECTRICAL INVENTION AND DISCOVERY

1820 A.D.-- Hans Christian Oersted (Denmark) discovered that an electric current deflects a suspended magnet.

-- Andre Ampere (France) demonstrated electromagnetic reaction.

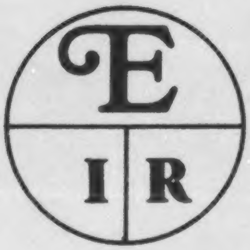
1821 A.D.-- England - Michael Faraday causes a current carrying conductor to rotate about a magnetic field. This laid the foundation for the electric motor.

1825 A.D.-- William Sturgeon (England) made the first electromagnet.

Name: ____________________

Date: ____________________

Period: ____________________



-- Georg Simon Ohm discovered that voltage, current, and resistance have a certain predictable interrelationship. Ohm's Law was presented - E = I x R.

1831 A.D.-- Joseph Henry (U.S.A.) and Michael Faraday (England) independently discovered the phenomenon of electromagnetic induction and the generation of electricity by magnetism.

-- Faraday constructs a disc dynamo, the first electro-mechanical generator.

-- Henry discovers self-induction or inductor action.

1837 A.D.-- Samuel Morse (U.S.A.) invents the first practical telegraph.

1839 A.D.-- Karl Gauss (Germany) publishes his theory of magnetism and forces of attraction.

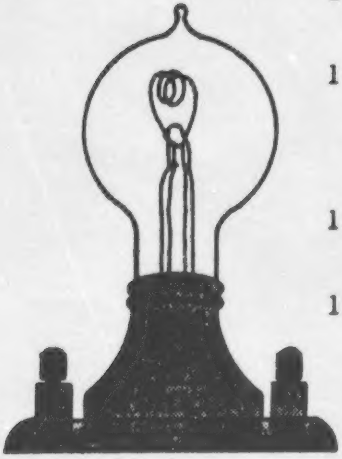
$$\begin{array}{r} 1 \\ +1 \\ \hline 10 \end{array}$$

1841 A.D.-- Arc lamps first demonstrated in Paris.

1847 A.D.-- George Boole establishes the foundation of modern computer operation in his "mathematical logic." Known today as Boolean Algebra.

1858 A.D.-- Faraday supervises the installation of dynamos used to power arc lights in English lighthouses.

1866 A.D.-- Cyrus Field lays the first successful transatlantic telegraph cable.



1873 A.D.-- James Maxwell (England) publishes his scientific paper on the theory of electromagnetic radiation. This formed the mathematical foundation for radio waves.

1876 A.D.-- Alexander Graham Bell (U.S.A.) develops the first practical telephone.

1879 A.D.-- Thomas A. Edison (U.S.A.) invents the carbon-filament lamp. First practical incandescent lamp.

-- Ernest W. Von Siemens (Germany) successfully demonstrated a three-car electric train.

1880 A.D.-- Edison installs electric street lighting in New York City.

Name: ____________________

Date: ____________________

Period: ____________________

1883 A.D.-- Edison Discovers the Edison Effect, which formed the basis for vacuum tube discoveries.

1886 A.D.-- Heinrich Hertz (Germany) verified the mathematical predictions of Maxwell by producing electromagnetic waves, and thus opening the field of practical radio.

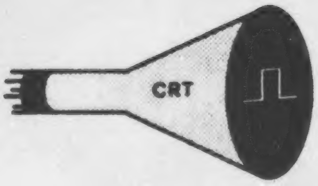
-- Edison patents carbon microphone.

-- Alternating current first used in America for a commercial lighting system.

1888 A.D.-- Nikola Tesla (U.S.A.) invents the AC induction motor. A company named Westinghouse manufactures it.

1892 A.D.-- General Electric Company formed.

1896 A.D.-- Italy - Guglielmo Marconi sent radio telegraph messages over a distance of 9 miles.



1897 A.D.-- Marconi demonstrates ship-to-shore wireless.

-- Karl Ferdinand Braun constructs first cathode-ray oscilloscope.

1899 A.D.-- Sound first recorded on magnetic wire.

1900 A.D.-- William Duddel discovers that an electric arc can be made to produce continuous oscillations This formed the basis for early spark-gap transmitters.

-- Prof. Reginald Fessenden first transmits speech by wireless.

1901 A.D.-- First transatlantic wireless message.

1903 A.D.-- Dr. Ernest Alexanderson builds first high-frequency alternator at General Electric which produced a 100 Khz wave.

1904 A.D.-- Prof. John Fleming patents a two-element thermionic device called the Fleming Valve based upon the Edison Effect. It was used to detect Hertzian waves and is known today as the diode tube.

THE VACUUM TUBE ERA (1905-1948):

1906 A.D.-- General Dunwoody develops the crystal detector which utilized carborundum to "detect" signals

Name: ____________________

Date: ____________________

Period: ____________________

triode

-- Dr. Lee de Forest (U.S.A.) adds a grid to the Fleming Valve producing the audion tube, a three element device which laid the foundation of modern electronics. The audion tube is known today as the triode tube.

1915 A.D.-- First transatlantic radio telegraphy communication from the United States.

1917 A.D.-- George Campbell develops the first electrical wave filter. Making possible communication "channels."

1920 A.D.-- KDKA Pittsburgh - the first broadcast radio station begins operation.

-- Edwin Armstrong designs the superheterodyne circuit - forerunner to modern radio receivers

1923 A.D.-- Dr. Vladimir Zworykin patents iconoscope TV camera tube.

TV

1925 A.D.-- TV demonstrated by John Baird in England.

1929 A.D.-- Dr. Vladimir Zworykin demonstrates the kinescope, the first "modern" picture tube.

1930 A.D.-- Col. W. Blair patents first basic radar system

1931 A.D.-- Oscilloscope produced by Allen DuMont.

1933 A.D.-- Karl Jansky discovers radio astronomy.

1937 A.D.-- Varian Brothers invent the Klystron tube - a high power microwave oscillator.

1938 A.D.-- William Hewlett and David Packard work to produce a diathermy machine for Stanford Hospital.

1939 A.D.-- NBC demonstrates TV broadcast utilizing the new orthicon camera developed by RCA.

RADAR

1941 A.D.-- Commercial FM broadcasting began in U.S.A. on January 1.

-- Commercial TV authorized by the FCC on July 1.

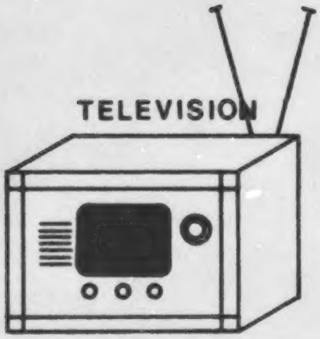
-- First military application of newly developed radio-detection device (radar) December 7, at Pearl Harbor.

1942 A.D.-- Magnetic recording tape developed.

Name: ____________________

Date: ____________________

Period: ____________________



1944 A.D.-- One of the first digital computers developed by Howard Aiken at Harvard University called the automatic-sequence-controlled calculator and was used extensively by the U.S. Navy.

-- V-beam radar introduced by MIT's radiation lab. - First practical do-everything radar.

1946 A.D.-- RCA introduces the first mass produced B&W television; model 630TS - 10 inch picture tube, sold for $375.

-- Eniac computer developed by Eckert and Mauchly at the University of Pennsylvania. Digital programmable machine, 5000 arithmetic calculations per second, weighed 30 tons, contained 18,000 vacuum tubes, and required 130KW of power. By todays standard Eniac was comparable to a basic hand held calculator.

-- RCA demonstrates the first "all electronic" color TV.

1947 A.D.-- Bell labs - December: the first signal amplified by a semiconductor crystal is observed. The work of John Bardeen, Walter Brattain, and William Shockley results in the Germanium Point-Contact Transistor.

THE TRANSISTOR ERA (1948-1959):

TRANSISTOR

1948 A.D.-- The transistor is born - the beginning of modern electronics.

1949 A.D.-- The record business is shattered; the 78 RPM is out. RCA introduces the 45 RPM disc, while CBS developed the 33-1/3 format.

1951 A.D.-- Univac I computer introduced by the Remington-Rand Corporation.

1952 A.D.-- RCA experiments with the first all transistorized television set.

-- Andrew Kay develops the first digital voltmeter at Non Linear Systems Company.

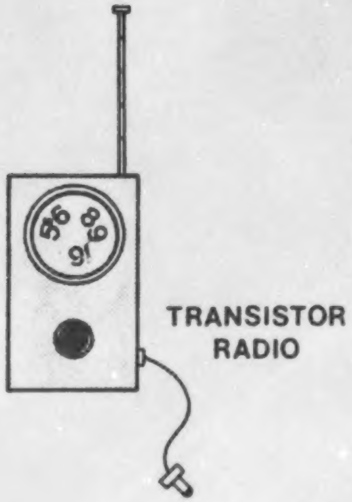
1953 A.D.-- H.J. Zeigler developes the beam maser - a device that could amplify microwave signals with light. This amplifier was the forerunner of the laser.

Name: ____________

Date: ____________

Period: ____________

-- Tektronix introduces the concept of plug-in modules for test equipment.



1954 A.D.-- Bell labs perfects a method of growing single crystal silicon. This development laid the foundation for today's multibillion-dollar semiconductor industry.

-- Calvin Fuller of Bell labs developed the process of diffusing impurities into the surface of silicon wafers, paving the way for the development of the integrated circuit.

-- Texas Instruments introduces the silicon transistor.

-- Daryl Chapin, Calvin Fuller, and Gerald Pearson at Bell labs develop the solar battery (cell).

-- First application of transistors to consumer products. Regency Company markets a four-transistor radio.

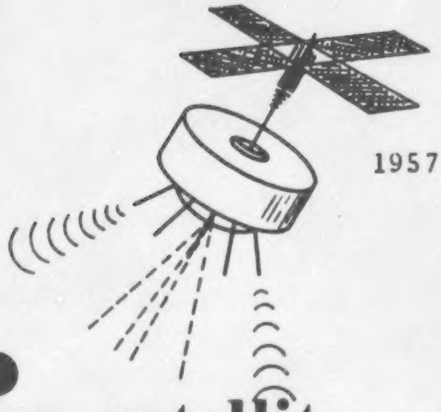
1955 A.D.-- Tappan introduces the microwave oven for home use.

Mucan Corporation and Bell labs develop the varacator diode then known as the voltage-variable capacitor, and used today for electronic tuning with no moving parts in TV's and radio's.

1956 A.D.-- Bell and Howell introduces the all-electronic movie camera.

-- Bell labs demonstrates the feasibility of the TV telephone.

-- GE commercialized the silicon-controlled rectifier (SCR).



satellite

1957 A.D.-- Russia launched Sputnik - the first man made orbital satellite.

-- Burroughs Corporation develops the first gas-discharge numerical readout tube - the nixie.

-- U. Gianola of Bell labs developed the plated wire memory. At IBM, large rotating discs were used for the first time to make a random access memory capable of storing up to five million characters.

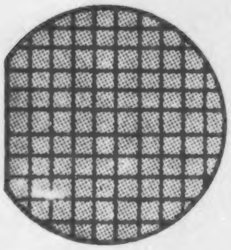
Name: ____________________

Date: ____________________

Period: ____________________

-- RCA unveils a miniaturized FM transmitter small enough to be swallowed. Today's astronauts use modern versions of these pill transmitters to send physical data back to earth.

1958 A.D.-- The first integrated circuit is developed by Jack Kilby at Texas Instruments. The crude circuit contained several transistors, a few resistors, and some capacitors. Today, a similar sized IC could contain ten thousand transistors. At about the same time, at Fairchild's Semiconductor Division, Dr. Robert Noyce developed a similar type of circuit in which all components were integrated or formed on a single chip of silicon.



Silicon Wafer

-- GE and Crystalonics introduces commercial field effect transistors (FET).

-- Stereo phonograph records begin to appear. A few radio stations begin to broadcast in stereo.

1959 A.D.-- RCA introduces the nuvistor, a thimble-sized vacuum tube which heralded the last attempts of tube manufacturers to compete against transistor devices.

THE INTEGRATED CIRCUIT ERA (1959-):

Light
Amplification by the
Stimulated
Emission of
Radiation

1960 A.D.-- Fairchild develops the planar process for the production of transistors and ICs. This process involves the evaporation of aluminum over the circuit to form conductors.

-- Texas Instruments offers first IC product line called the "solid circuit series 1" which consisted of simple logic circuits.

-- Bell labs develops the epitaxial process which allowed a crystal structure to be grown on a substraight or another crystal structure. This technique became the mainstay of transistor and IC fabrication.

1961 A.D.-- Laser devices developed by Hughes, Bell labs, Raytheon, and IBM.

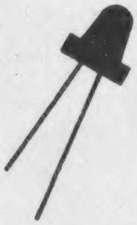
1962 A.D.-- Solid-State laser developed at both GE and IBM research labs.

-- Signetics introduces diode-transistor logic.

Name: ____________________

Date: ____________________

Period: ____________________



LED

-- First light-emitting diodes (LEDs) developed, although they were not commercially available until 1968.

-- **Telestar** communications satellite launched on July 10, making possible satellite relayed communication via telephone and television.

1963 A.D.-- The first commercial mini-computer was introduced by Digital Equipment Corporation model PDP-5 used a 12 bit format, and contained 1K of memory. It sold for $27,000.

-- Sylvania introduces the first integrated circuits utilizing TTL logic, designated as Sylvania's universal high level logic.

1964 A.D.-- IBM introduces the system 360 computer series, intended to replace all existing IBM computer series.

-- Zenith produces one of the first consumer products which utilized integrated circuits, a hearing aid.

-- Texas Instruments introduces the 5400 series TTL logic series.

-- Fairchild introduces one of the first linear ICs - the 702 OP amp.

-- Dual-inline-package (DIP) first appears.

1966 A.D.-- Andrew Bobeck announces the development of magnet-bubble devices.

1968 A.D.-- RCA introduces a new IC technology - COS/MOS.

1969 A.D.-- July 20, Apollo 11 astronauts Armstrong and Aldrin land on the moon. The successful landing, and return to earth culminated a decade of break-throughs in electronics.

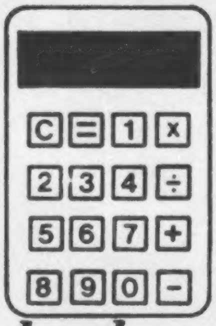
1970 A.D.-- Intel develops the first dynamic MOS random-access memory (RAM), a 1025-bit device. Prior to this development, computer memories utilized magnetic cores or semiconductors.

-- Mostek and TI show that all the logic for a four function calculator could be put on a single chip utilizing a technique known as MOS/LSI.

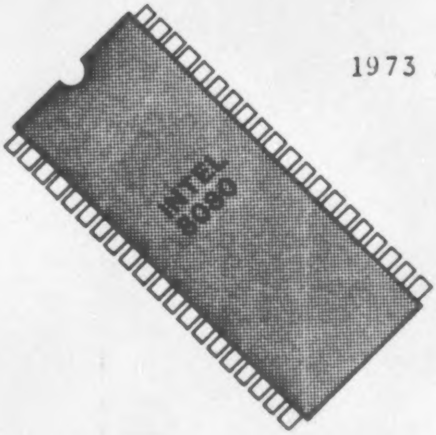
Name: ____________________

Date: ____________________

Period: ____________________



calculator



I.C.

-- Harris Semiconductor introduces the PROM a new user-programmable memory..

-- Hamilton introduces the "Pulsar," an LED display wristwatch. Cost $2100.

1971 A.D.-- Ted Hoff spearheads the development of the first microprocessor - Intel's 4004. Shortly thereafter the 8008 CPU chip is introduced.

-- Hand-held calculators make their debut. Simple 4 function units produced by Hewlett-Packard, Sharp, and Texas Instruments sold for $400.

1972 A.D.-- Liquid crystal displays offer a new technology for numerical displays, offering the advantage of low power consumption, and high visability in daylight conditions.

-- Microma Universal introduces the first commercial liquid crystal display wrist watches. Cost $150.

-- Magnavox markets the first Odyssey TV game units. Atari followed with Pong in 1976.

1973 A.D.-- Intel upgrades the 8008 and introduces the 8080. National Semiconductor and Rockwell field their own microprocessor designs.

-- I^2L (integrated-injection logic) emerges due to the work of IBM and Philips. This new circuit technique allows high density, high operating speed, and low dissipation. The first I^2L products - a 4-bit microprocessor and a watch circuit - were introduced by Texas Instruments.

-- Advent introduces "Video Beam" projection TV.

1975 A.D.-- Home video tape recorder systems presented by AVCO (Cartivision), Sony (Betamax), and others.

-- Microprocessor based home computers begin to appear in the hobby and engineering market. The first units were sold in kit form by companies such as MITS (Altair), Sphere, IMSAI, and Southwest Technical Products. These first machines were generally 8080 or 6800 based. The machines became financially

Name: ____________________

Date: ____________________

Period: ____________________

Large SCALE Integration

feasible due to the cost effective production of LSI chips which dropped the price of the original microprocessor chip from $200 to $20 each.

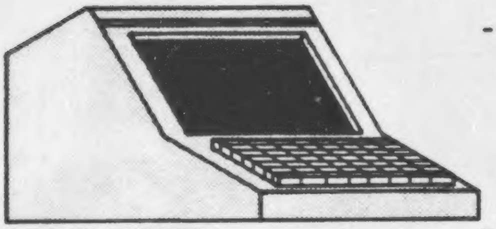
-- Ionization and optical smoke detectors introduced for home use.

1976 A.D.-- The body scanner, an x-ray type machine which is capable of analyzing the complete body for medical growths, tumors, bone problems, etc. is introduced by GE.

-- Breakerless electronic ignition systems become available as original equipment or add-on for automobiles.

1977 A.D.-- 40-channel CB radio approved by the FCC.

-- New generation of home computers emerge. These systems are pre-assembled, offer simplified programming techniques, and are comparitively low in cost. The Radio Shack TRS-80, Commodore PET, and Apple II are examples of this new breed.



HOME COMPUTER

-- The world's first optical (fiber-optic) communications system to provide regular telephone service was placed in operation by General Telephone Company. This feat culminated years of work in development and experimentation with optical fibers and appropriate light sources.

1978 A.D.-- New era microprocessor chips based upon 16 bit words instead of the more common 8 bit word length promise to deliver 10-times the performance of the industry-standard 8080 chip.

WHAT NEXT?

SCORE:

GRADE:

Name: ____________________

Date: ____________________

Period: ____________________

ANSWER SHEET

EXAM LII U3

	T A	F B	C	D		T A	F B	C	D		T A	F B	C	D		T A	F B	C	D
1.	F				26.					51.					76.				
2.	I				27.					52.					77.				
3.	C				28.					53.					78.				
4.	M				29.					54.					79.				
5.	A				30.					55.					80.				
6.	H				31.					56.					81.				
7.	K				32.					57.					82.				
8.	D				33.					58.					83.				
9.	J				34.					59.					84.				
10.	O				35.					60.					85.				
11.	G				36.					61.					86.				
12.	B				37.					62.					87.				
13.	L				38.					63.					88.				
14.	E				39.					64.					89.				
15.	N				40.					65.					90.				
16.					41.					66.					91.				
17.					42.					67.					92.				
18.					43.					68.					93.				
19.					44.					69.					94.				
20.					45.					70.					95.				
21.					46.					71.					96.				
22.					47.					72.					97.				
23.					48.					73.					98.				
24.					49.					74.					99.				
25.					50.					75.					100.				

*Show work for problems on back of answer sheet.

ANSWER KEY
UNIT 3

A. KNOW YOUR DEFINITIONS

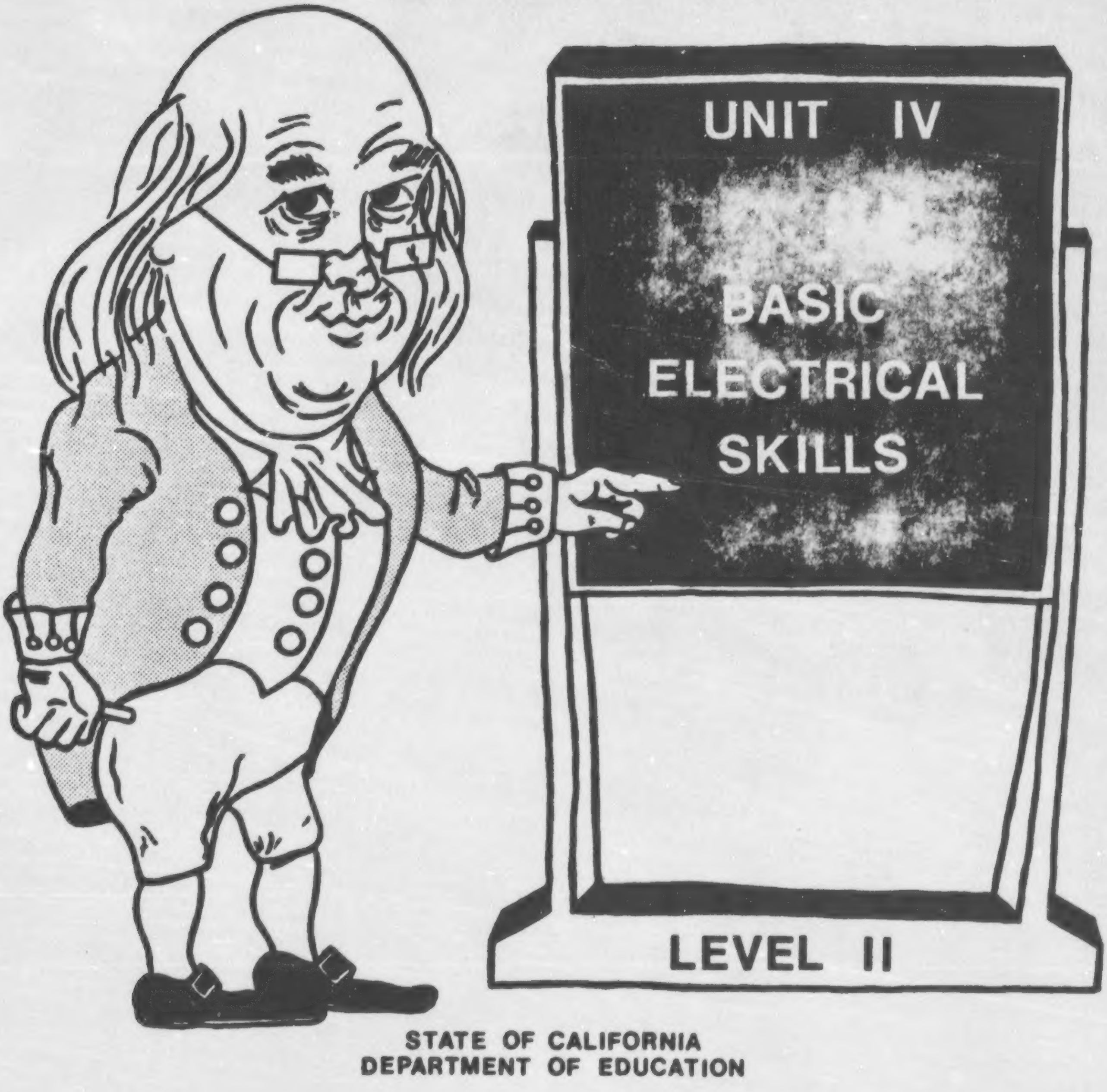
1. (subjective answer)
2. (subjective answer)
3. (subjective answer)
4. (subjective answer)
5. (subjective answer)
6. (subjective answer)

B. QUEST ACTIVITY

(subjective evaluation)

ELECTRICITY / ELECTRONICS

CURRICULUM GUIDE
INSTRUCTIONAL MODULE


UNIT IV
BASIC
ELECTRICAL
SKILLS
LEVEL II

STATE OF CALIFORNIA
DEPARTMENT OF EDUCATION

NAME____________________
DATE STARTED____________
DATE COMPLETED__________

BY
R. E. LILLO
N. S. SOFFIOTTO

STATE ELECTRICITY/ELECTRONICS CURRICULUM GUIDE
INSTRUCTOR'S GUIDE TO ACCOMPANY LEVEL II UNIT #4

Title of Unit: Basic Electrical Skills

Time Allocation: 4 weeks

Unit Goal:

To promote basic electrical skills and interest in electricity by conveying those competencies relevant to successful tool usage, wiring, and project assembly techniques.

Unit Objectives:

The student will be able to:

1. describe the function, list safety precautions, and illustrate the correct use of each construction tool presented in this unit.
2. identify and demonstrate proper soldering techniques and method of preparing conductors for electrical utilization.
3. successfully construct a Wiring Project, and demonstrate their competence in following instructions, tool use, chassis layout, soldering, assembly techniques, inspection, and testing.

Evaluation:

The student will demonstrate his/her competence in terms of these measurable objectives based upon individual instructors acceptable performance criteria, which utilizes a combination of written, oral, and laboratory testing procedures.

Instructor References:

Electronics Assembly and Fabrication Methods. S.R. Duarte and R.L. Duarte, McGraw-Hill Book Co., 1973. Chapters: 1, 5, 6, 7, 8, 9, and 10.

Electronic Techniques. R.S. Villanucci, A.W. Avtgis, and W.F. Megow, Prentice-Hall, Inc., 1974. Chapters: 3-16.

Technical Electricity and Electronics. Peter Buban and Marshall L. Schmitt, McGraw-Hill Book Co., 1977. Units: 27-31.

Overview:

Unit 4 will allow the student to develop competencies that will act as a foundation for future mechanical and electrical assembly tasks.

The unit should be introduced as a valuable resource in project planning and construction. The idea of constructing a project should be stressed as a necessary "hands on" experience in order to facilitate working with devices and processes.

The central theme is to present a variety of basic electrical skills for the students to develop, however, craftmanship is a quality that must be emphasized by the instructor as an on going process that should permeate all levels of activities.

Most major topics in this unit can be presented through laboratory demonstrations and the student wiring project can assist in evaluating student understanding.

This unit has a relatively long time allocation, yet for the student it focuses on a fascinating and motivating aspect of the course.

Suggested Presentation Hints/Methodology:

Follow the instructional module unit outline as a basic skeleton for curriculum presentation, however, note the following:

1. When illustrating basic hand tools and describing their function, an overhead projection can be easily adapted as a means to show tool outline or shape. In addition, physically tracing tools with color pencils can assist disadvantaged students in learning the basic differences in size, shape, etc.
2. When demonstrating practices encountered in assembly and fabrication, stop and describe large-scale production techniques. Indicate and show some of the jobs which are relatively simple and require little training, then describe more complicated jobs which require extensive preemployment training.
3. A project for the student to build is definitely mandatory in this unit, but it need not be a one to one situation. A class "assembly line" type project can teach a variety of techniques and require less cost to implement. Break the laboratory into three work stations; mechanical assembly, electrical assembly, and inspection/testing. Allow the students to perform only those skills associated with that work station, however, rotate students if you desire to expose them to other competencies.
4. At this educational level it is wise when instructing students in chassis construction or other fabrication techniques to utilize metal templates to assist in achieving the most positive results.

Supplemental Activities and Demonstrations:

1. The vocabulary list presented in this unit is long and cumbersome. Spend a good deal of time describing each term and if possible demonstrate each tool listed and emphasize safety precautions when appropriate.
2. Use discarded cardboard boxes as a material resource. Layout various component positions for project chassis or project front panel on a sheet of graph paper, then select the best design and cut a piece of cardboard to actual front panel dimensions. Attach all pots, switchs, lamps, jacks, meters, etc. where indicated and again check overall aesthetics. If there is an error in layout or a special problem in mounting a part this will be worked out on the cardboard model rather than on the original chassis or cabinet. This procedure will assist students in completing a project that is not only functional but also a pleasure to view.

Instructional Module Contents:

1. Unit Outline (overhead)
2. Pre-Post Test (keyed)
3. Technical Glossary
4. Worksheet (vocabulary) - Tool and Hardware Indentification
5. Worksheet - Soldering, Splices, and PC Fabrication
6. Quest Activities
7. Informational Handout (A 4 Step Guide to Soldering)
8. Informational Handout (Some General Assembly and/or Construction Hints)
9. Informational Handout (Electrical Connections)
10. Informational Handout (Printed Circuit Board Fabrication)
11. Informational Handout (Board Fabrication - Photographic Method)
12. Unit Module Answer Keys

IV. Basic Electrical Skills

A. Identification and Proper use of Basic Hand Tools

B. Soldering
   1. Heat, flux, and solder

   2. Preparations for soldering

   3. Making a solder joint

C. Making Simple Conductor Joints

   1. Preparing conductors

   2. Mechanical and electrical connections

   3. Splices

   4. Solderless connectors and terminals

   5. Terminal and socket connections

   6. Printed circuit soldering

D. Insulating Conductor Joints

E. Wire Types and Gauge Determination

F. Assembly Techniques
   1. Harness assembly

   2. Component assembly

   3. Chassis hardware and assembly

G. Printed Circuit Board Fabrications

H. Proper Use of Power Tools and Stationary Equipment

Test Number _____

LII-U4

UNIT EXAM

BASIC ELECTRICAL SKILLS

IMPORTANT-

Indicate your responses on the answer sheet only. Fill in the box corresponding to the correct answer to each question - there is only one correct answer for each question.

1. Wire strippers are used to remove the conductor from wires. (T-F)

2. A stranded wire is less flexible than a solid wire of the same gauge. (T-F)

3. Side-cutting pliers are sometimes called lineman pliers. (T-F)

4. A handpunch or chassis punch is used to make round holes in sheetmetal. (T-F)

5. The preferred solder to use in electronic project construction is 60/40 rosin-core solder. (T-F)

6. A dull-colored solder joint, on a PC board, is acceptable as long as enough solder is used. (T-F)

7. A wire being soldered to a lug is usually first loosely fastened to the lug to hold it in place. (T-F)

8. Conductors or traces on a printed circuit board often cross or overlap. (T-F)

9. Drilling holes in sheetmetal can be a dangerous operation. (T-F)

10. A chassis forms the base upon which a circuit is assembled or mounted. (T-F)

11. Diagonal-cutting pliers are designed for stripping wires. (T-F)

12. Pre-tinned hook-up wire is coated with a thin layer of tin to prevent the copper conductor from oxidizing. (T-F)

13. Long-nose pliers are designed primarily for holding and bending small-gauge wires. (T-F)

14. Do not move or handle a newly soldered wire until the solder has solidified sufficiently. (T-F)

15. The process of removing unwanted copper from a printed-circuit board, using a chemical solution, is called etching. (T-F)

16. A 24 gauge wire has a larger diameter than a No. 12 American Wire Gauge wire. (T-F)

17. Magnet wire is most often insulated with a coating of enamel or lacquer. (T-F)

18. The job of removing solder from a terminal or PC joint is done with an unsoldering tool. (T-F)

19. Sheetmetal can be cut with tin snips, aviation snips or the box and pan brake. (T-F)

20. A phillips head screw can be driven by either a standard blade screwdriver, or a Phillips screwdriver. (T-F)

21. The process of coating a wire, terminal, or soldering iron tip with a thin layer of solder is called __________.

22. Solder used for electronic work is usually in wire form and contains one or more cores of __________ __________.

23. The joining together (twisting) of two or more wires to form a permanant connection is called a _________.

24. When soldering components which are sensitive to excessive heat a tool called a _________ _________ should be used.

25. An important step in PC fabrication is to thoroughly _________ the board to remove dirt and grease.

Name: ____________________

Date: ____________________

Period: ____________________

TECHNICAL GLOSSARY

ADJUSTABLE WRENCH:	An open-end style wrench with adjustable jaw size. This type of wrench is designed with one stationary jaw, and an adjustable jaw operated by a thumb screw. This feature allows one wrench to be used on many different nut or bolt sizes.
ASSEMBLY:	The fitting together of parts, utilizing tools and necessary equipment, to form a complete unit or device.
AVIATION SNIPS:	Sheetmetal cutting shears which have a compound lever action which reduces cutting effort.
BALL-PEEN HAMMER:	A general purpose metal working hammer with one flat face for hammering and a rounded or "ball" head for rounding off rivets.
BOX AND PAN BRAKE:	A heavy duty sheetmetal tool with adjustable fingers used to make inside and outside bends from about 180° to 40°.
CABLE TIES:	Small nylon belts or straps, with a self-locking buckle, used to bind or harness wires together.
CENTER PUNCH:	A metal punch with a sharp 60° point. The center punch is used to mark the location of a hole that is to be drilled and thus eliminate drill "wandering."
CHASSIS:	A metal box or frame upon which major components or sub-circuits are mounted and wired.
CHASSIS PUNCH:	A sheetmetal punch designed for punching round holes in a range of sizes from 1/2" to 3". The punch halves are drawn together with a machine screw. Chassis punches are also available in square, keyed, and half round styles.
COMPONENT:	A general term describing an electrical part or parts. For example; basic electrical parts such as resistors, capacitors, diodes, and transistors, can be identified as components.
CONDUCTOR JOINTS:	A method for connecting or securing two or more wires together. A satisfactory conductor joint must be 1) mechanically secure - wires tightly twisted together, 2) electrically secure - the connection must freely pass current, and 3) covered with an approved insulation.
DESOLDERING TOOL:	A device used to remove molten solder from a wire or connection. Most desoldering tools draw the molten solder from the connection with a vacuum or suction force.

DIAGONAL-CUTTING PLIERS:	Pliers used for cutting soft metal wire. Two popular terms used for identifying these pliers are diagonals and dykes.
DRILL PRESS:	A motorized tool used for drilling or boring holes in a piece of stock. Drill bits are held securely in the chuck, and fed into the work with the feed handle.
ELECTRICAL CONNECTION:	Provides a connection that will conduct electricity as efficiently as a continuous wire. A good electrical connection requires that the wires be absolutely clean and that they be twisted together to achieve good contact, many times solder is added to the joint to achieve good electrical contact.
ELECTRICAL TAPE:	A black vinyl insulating tape used to cover exposed conductor joints.
ETCHING:	The process of chemically removing the excess copper from a circuit board. The more common etching solutions are ammonium persulfate or ferric chloride.
FILE:	A tool used mainly to smooth the edges of sheetmetal, and to do small amounts of cutting, shaping and fitting of metal parts.
FLUX:	A chemical used to remove oxygen during the soldering process and to clean the copper surface of slight oxidation. Flux aids in making a good solder joint. For electrical work use only rosin flux, which is available as a paste, or as a core in the solder itself.
GAUGE:	A standard method for sizing wires. Gauge sizes are given as numbers, such as 24 gauge or 24g. The lower the number, the larger the diameter of the wire.
HACKSAW:	A hand saw used for cutting metal. The hacksaw cuts on the forward motion only.
HAND PUNCH:	A sheetmetal hole punch used for punching small round holes up to approximately 1/2" in diameter. The tool uses a collection of punch and die sets which are mounted (one size at a time) in a handle/frame unit.
HARDWARE:	Items designed to provide physical or electrical support for projects. Physical support hardware includes items like screws, bolts, clamps, nuts, and spacers, while electrical support items include switches, lamps, sockets, fuses and terminals.
HARNESS:	Individual wires tied together into a neat bundle and routed through the project as a group. A harness typically has wires leaving the bundle at various locations.
HEAT SINK:	A small metallic tool used to draw heat away from a component or connection during the soldering process.

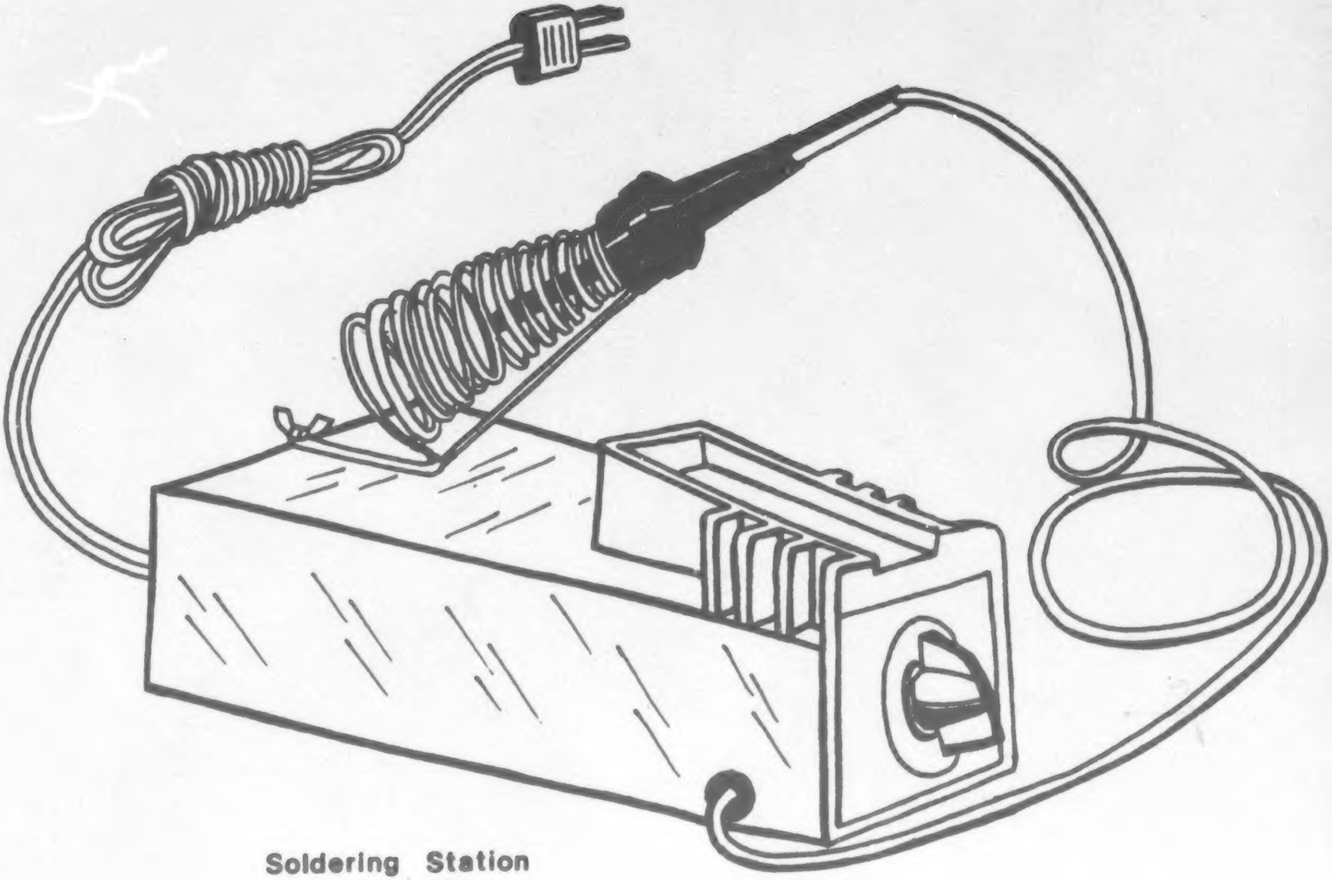
HEAT SHRINKABLE TUBING:	An insulating tubing which is slipped over a connection or joint. When the tubing is heated, with a heat gun, match, or soldering iron, it will shrink and form tightly around the connection.
INSULATION:	A material placed around a conductor, connection, or joint to prevent a short circuit or an accidental shock.
LACING:	The process of making a series of special ties with a piece of lacing cord along the length of a cable.
LONG-NOSE PLIERS:	Pliers used primarily for handling small objects and for bending and shaping wires. Most long nose pliers also incorporate a cutting jaw for cutting small gauge wires.
MAGNET WIRE:	Wire used in making coils in inductors, small transformers, relays, etc. The wire is usually insulated with a clear coat of enamel or varnish.
MECHANICAL CONNECTION:	The process of attaching wires to terminals, or another wire, by twisting or bending them in such a way that the connection remains secure even though it is not soldered.
NUT DRIVER:	A tool designed to rapidly install or remove nuts. The tool resembles a socket wrench attached to a screwdriver handle.
OPEN-END WRENCH:	A general purpose wrench which has an open jaw, of different size, at either end of the tool.
PORTABLE ELECTRIC DRILL:	A hand-held power tool used for boring holes in various materials. The tool utilizes a chuck to hold the drill bit and generally has a trigger style switch as a control.
PRINTED CIRCUIT BOARD:	Consists of metal foil conductors, usually copper, bonded to a substrate or base material. The base material supports the components which are loaded into holes drilled in the board, and soldered to the conducting foil. Foil traces serve as the interconnecting wires for the circuit.
RESIST:	A material used in printed circuit board fabrication to cover or coat the areas which are to be saved on the copper-clad board. The resist will form a pattern similar to the pattern of the completed printed circuit board traces.
SCREWDRIVER:	A tool which allows you to produce a twisting motion to tighten or loosen screws. The two common tip types are slotted or standard and Phillips-head.
SIDE CUTTER PLIERS:	Side cutter pliers or lineman pliers are heavy duty pliers used for gripping and cutting large gauge wires.
SLIP JOINT PLIERS:	A common type of plier designed for holding or gripping work. The slip joint permits the jaws to be opened wider.

SOLDER:	An alloy of tin and lead which is melted into an electrical connection to increase conductivity, improve mechanical strength and to protect against oxidation. Solder used for electrical work is generally designated as 60/40 rosin core. That is: 60% tin and 40% lead with a central core of rosin. This type of solder has a melting point of 370° F, good mechanical strength, and solidifies rapidly.
SOLDER JOINT:	The process of cleaning, heating, and properly applying solder to a connection, splice, or joint.
SOLDERING IRON:	A tool, with a heated tip, used to transfer heat to a connection for soldering. The style of iron used for general electronic work is called a "pencil" iron and has a rating between 25 and 40 watts.
SOLDERLESS CONNECTOR:	Also designated as solderless terminals or crimp connectors, these devices do not require soldering, rather, the wire is inserted into a lug, and the lug is squeezed, with a special tool, to make the electrical connection.
SOLID WIRE:	A style of wire that consists of only one solid conductor, usually surrounded by insulation.
SPLICE:	A method for connecting two or more wires together. Ex. Tap splice, rat-tail splice, or Western Union splice.
SQUARING SHEAR:	A piece of stationary equipment used for cutting, trimming, and squaring sheetmetal. The cutting blade is operated either by a foot treadle or lever handle.
STRANDED WIRE:	A type of wire which consists of many strands of fine wire twisted together. The twisted conductors are then covered with an insulating material. Stranded wire is more flexible than solid style wire of the same gauge.
TAPPERED HAND REAMER:	A "T" shaped tool used to slightly enlarge the size of a hole drilled in metal or sheetmetal.
TINNING:	The process of cleaning and coating with solder. Tinning is usually thought of in connection with preparing the heated tip of a soldering iron, but wires, terminals, printed circuit boards, and component leads are often tinned in preparation for making an electrical connection
TIN SNIPS:	A scissors like tool used for cutting sheetmetal.
TRACE:	Copper foil patterns which are left on a printed circuit board. These foil traces act as the interconnecting wires between the components.
TWIST-ON CONNECTOR:	A type of insulated solderless connector used for making rat-tail joints. To use a twist-on connector, thread it onto a pair of bare conductors which are held parallel to each other. The conductor will twist and hold the conductors firmly together.

TWIST DRILL: A style of drill bit made of carbon steel, and used for drilling holes in metals. The twist drill is used in conjunction with a drill press or portable electrical drill.

VISE: A tool used to securely hold work pieces while drilling, cutting, soldering, etc.. The most common style of vise, is called a bench vise, although many specialty vises are available for electronics work.

WIRE STRIPPERS: A common tool used to remove the insulation from a conductor or wire.



Soldering Station

SCORE:

GRADE:

Name: ____________________

Date: ____________________

Period: ____________________

WORKSHEET

VOCABULARY - TOOL AND HARDWARE IDENTIFICATION

Identify the items pictured below. Use complete names.

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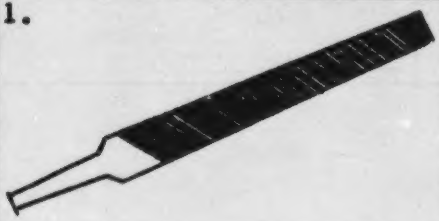

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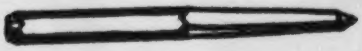

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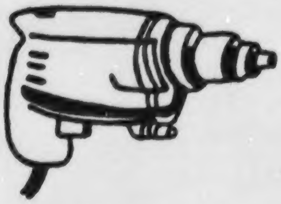

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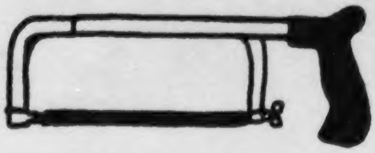

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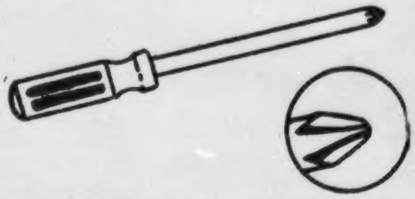

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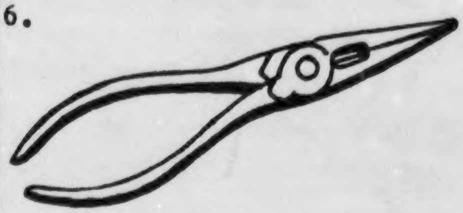

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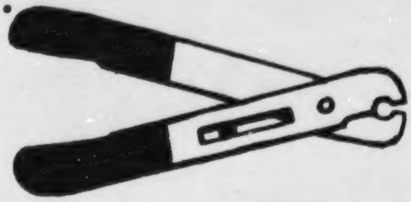

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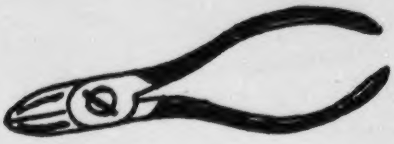

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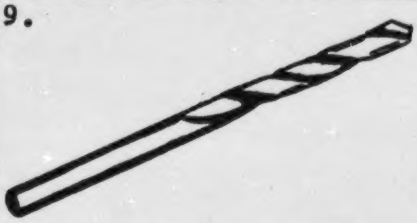

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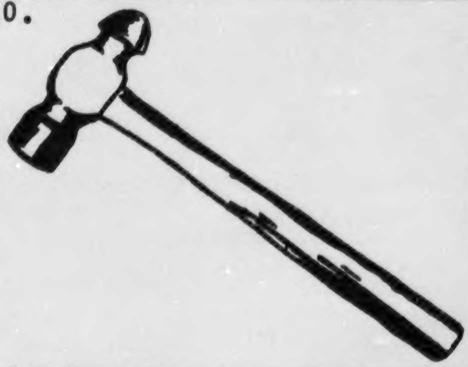

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Name: ____________________

Date: ____________________

Period: ____________________

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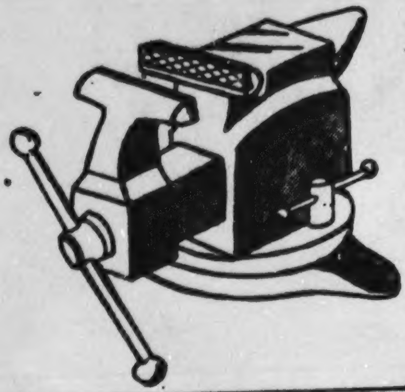

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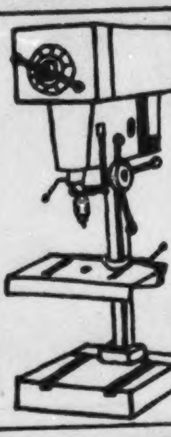

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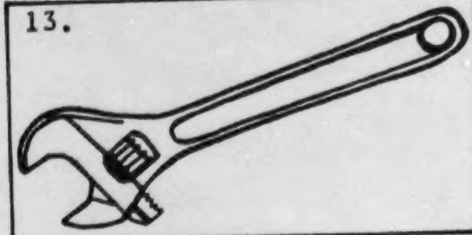

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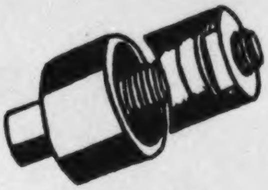

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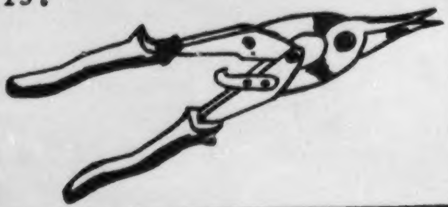

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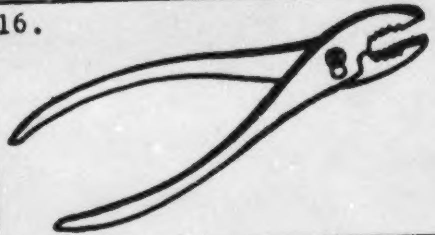

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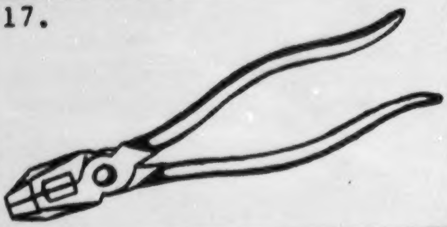

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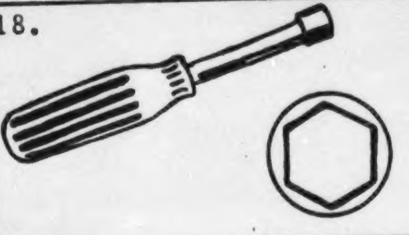

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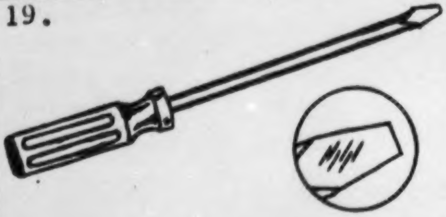

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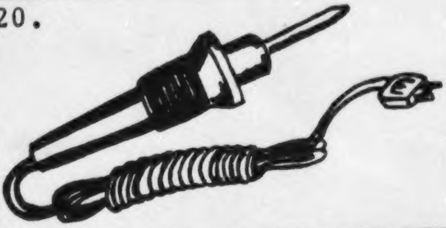

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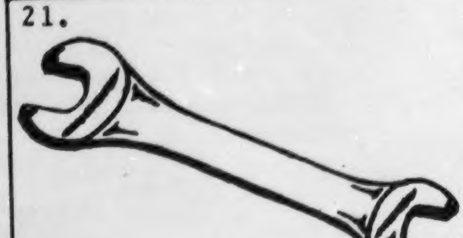

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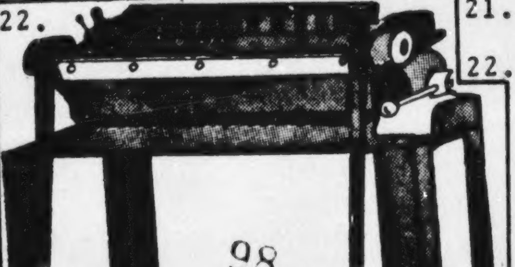

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Name: ____________________

Date: ____________________

Period: ____________________

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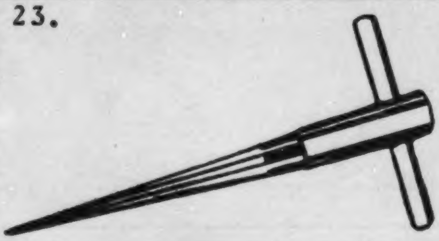

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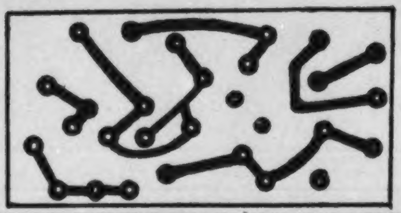

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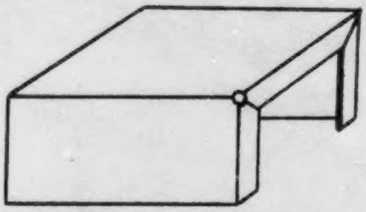

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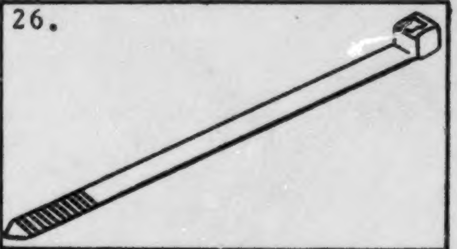

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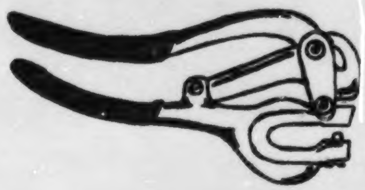

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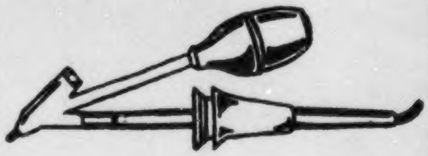

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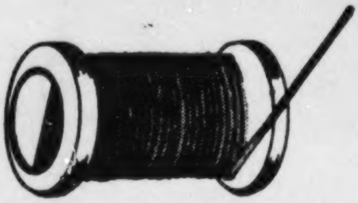

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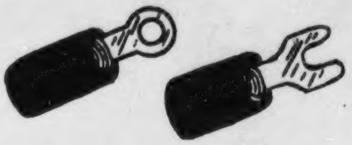

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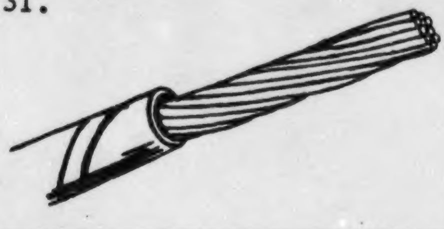

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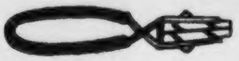

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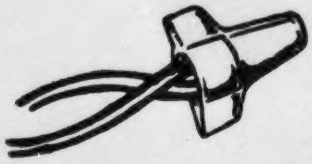

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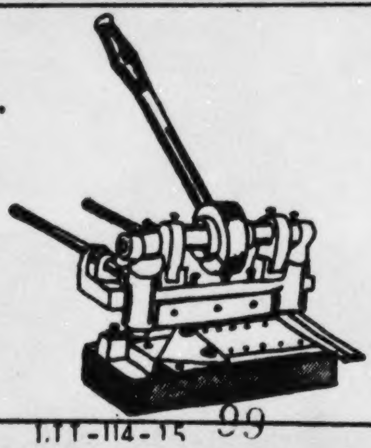

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SCORE:

GRADE:

Name: ____________________

Date: ____________________

Period: ____________________

WORKSHEET

SOLDERING, SPLICES, AND PC FABRICATION

1. Identify the three important reasons for soldering an electrical connection:

1	2	3

2. Make a list of the steps that should be followed in making a good solder connection. Explain each step where necessary.

3. Draw a neat sketch of the following types of wire splices.

Rat-Tail Splice

Name: ____________________

Date: ____________________

Period: ____________________

Tap Splice

Western Union Splice

4. Describe the method or technique used in the laboratory for applying resist material to a PC board. Be specific.

Apply Resist Material

5. Explain the procedure and precautions to be followed while etching a PC board.

Procedure	Safety Precautions
Etch the Board	

SCORE:

GRADE:

Name: ________________

Date: ________________

Period: ________________

WORKSHEET

QUEST ACTIVITY
"UNIT 4"

PURPOSE:

The project you are about to begin has a definite purpose. As you proceed through the assembly process you will gain important experience in chassis fabrication, hand tool usage, soldering, point to point wiring, and cable harnessing/layout. Keep in mind; your aim is to work carefully and produce a quality product.

PARTS LIST:

Item #	Quantity	Ref. Design	Description	Inv. Ck.✓	Cost
1	1		Metal chassis 5"x6", 26 guage		
2	1	V_1	Socket, 7 or 9 pin min. tube		
3	2	TB_1 , TB_2	Term. strip. 5 LUG		
4	1	TB_3	Term. strip. 3 LUG		
5	5		Mach. screw 4-40x3/8		
6	5		Nuts, 4-40x3/16		

WIRING CHART:

FROM	TO	
V1-1	V1-5	____
V1-2	V1-4	____
V1-1 (S)	TB1-D	____
*Progress check		______
V1-2 (S)	TB1-E	____
V1-3 (S)	TB1-A	____
V1-4 (S)	TB1-B	____
V1-5 (S)	TB2-E	____
V1-6 (S)	TB2-B	____
V1-7 (S)	TB2-A	____
TB1-A	TB2-E	____
TB1-A (S)	TB1-C (S)	____
TB1-B (S)	TB1-E	____
TB1-D (S)	TB2-A	____
TB1-E (S)	TB2-B	____
TB2-A (S)	TB2-C	____
*Progress Check		______
TB2-B (S)	TB2-D	____
TB2-C (S)	TB3-B (S)	____
TB2-D (S)	TB3-A	____
TB2-E (S)	TB3-C	____
TB3-A (S)	LEAD*	____
TB3-C (S)	-LEAD	____

LEAD* - 4" Red lead for positive battery connection.

-LEAD - 4" black lead for negative battery connection.

Name: ____________________

Date: ____________________

Period: ____________________

PROCEDURE:

Chassis Construction:

1. Using the dimensions from the chassis layout diagram, (or a layout template) and a scriber, mark your metal for the location of fold lines and holes.

   If you use a template: Be sure the template is positioned with the correct side up.

2. Using a hand punch, make the holes for the machine screws and tube socket.

   Holes labeled "X" are 1/8" diameter - use 1/8" punch. Holes labeled "Z" are 1/4" diameter - use 1/4" punch.

   If you mark the center of each hole with a center punch, it will be very easy to accurately locate the holes.

3. Using the 5/8" chassis punch, enlarge the 1/4" hole to 5/8".

4. Using the box and pan brake, bend the two sides of the metal chassis.

   Align the bend lines, marked on your metal, with the edge of the fingers on the brake, and make a 90 degree bend.

5. Mount the tube socket and terminal strips on the chassis using the machine screws and nuts. Be sure the nuts are on the back side of the chassis.

   See the attached drawings for location of parts.

6. Using masking tape, label the terminal strips and tube socket. Number the tube pins and letter the lugs on the terminal strips.

*Progress Check ____________________

GENERAL WIRING INSTRUCTIONS:

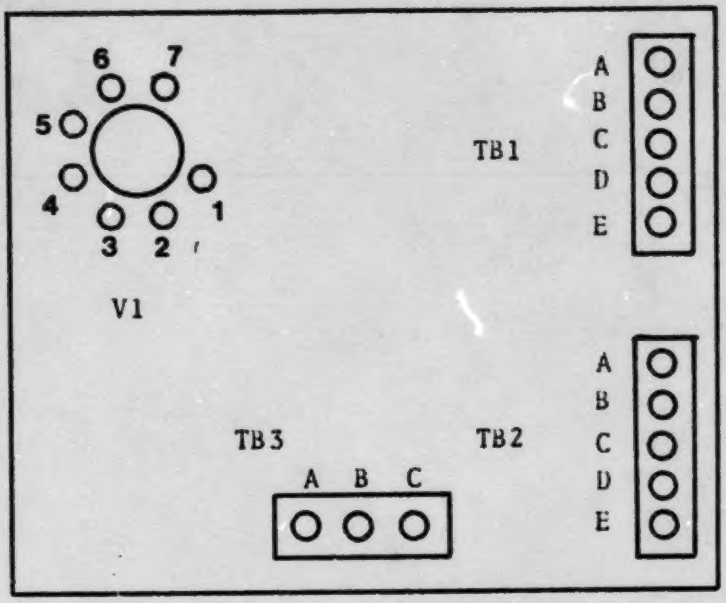
1. Check off each item on the wiring table as you complete that step.
2. Use your own judgment for best layout or routing of the wires.
3. Solder all connections. "(S)" after a location on the wiring table indicates that all the wires on that terminal should be soldered. Do not solder any wires until an "(S)" appears.
4. Lace or tie the wire bundle.
5. Tin the wire before connecting it to the terminal.
6. When making a wire connection, loop the wire around the terminal only once.

Name: ______________

Date: ______________

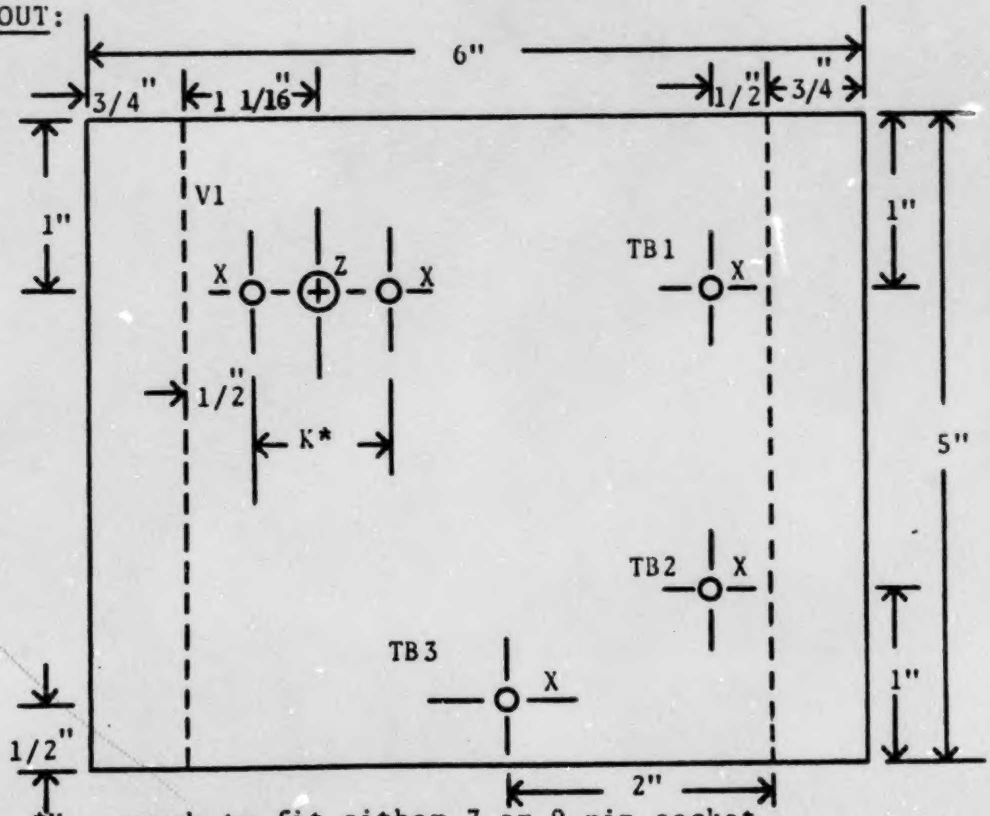
Period: ______________

PARTS PLACEMENT:


6
7
5
4
1
3
2
V1
TB1
A
B
C
D
E
TB3
TB2
A
B
C
A
B
C
D
E

NOTE: V_1 may be a 7 or 9 pin tube socket.

CHASSIS LAYOUT:


6"
3/4"
1 1/16"
1/2"
3/4"
1"
V1
X
Z
X
TB1
X
1"
1/2"
K*
5"
TB2
X
TB3
X
1"
1/2"
2"

*K - punch to fit either 7 or 9 pin socket.

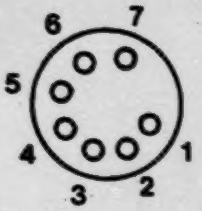
Name: ____________________

Date: ____________________

Period: ____________________

THEORY OF OPERATION:

The circuit consists of a 4 branch parallel circuit. When wired correctly the supply voltage will appear at the tube socket terminals in proper polarity as shown below.



Negative : Potential will appear at pins 1,3,5, and 7.

Positive : Potential will appear at pins 2,4, and 6.

PROJECT TESTING:

Connect the project leads (red and black) to the appropriate DC power supply (approx. 6 VDC) - red lead to the positive terminal, and black lead to the negative terminal. Plug the L.E.D. testing fixture into the tube socket, and turn on the power supply. If the project is correctly wired all L.E.D.'s will light. If the power supply indicates a "short" condition, or one or more L.E.D.'s does not light, proceed to "troubleshooting."

TROUBLESHOOTING:

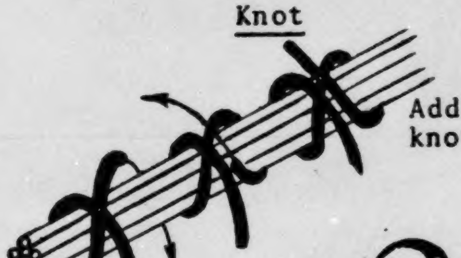
Don't dispair, problems are usually minimal and easily solved. Use the following outline to help you in finding your problem.

- I. Look for any bridges or shorts caused by solder, or crossing bare wires. Check:
  - A. Tube socket terminals
  - B. Terminal strip lugs
  - C. Wire to wire shorts (insulation melted)
- II. Wire connected to the wrong terminal*
- III. Extra wires*

*Use the wiring chart to recheck wire connection points.

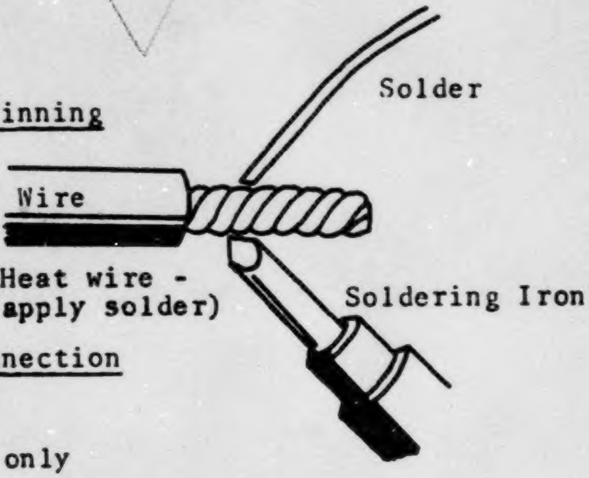
CONSTRUCTION TECHNIQUES:

Knot



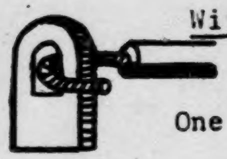
Add a square knot on top.

Tinning



(Heat wire - apply solder)

Wire Connection



One turn only

Name: ____________________

Date: ____________________

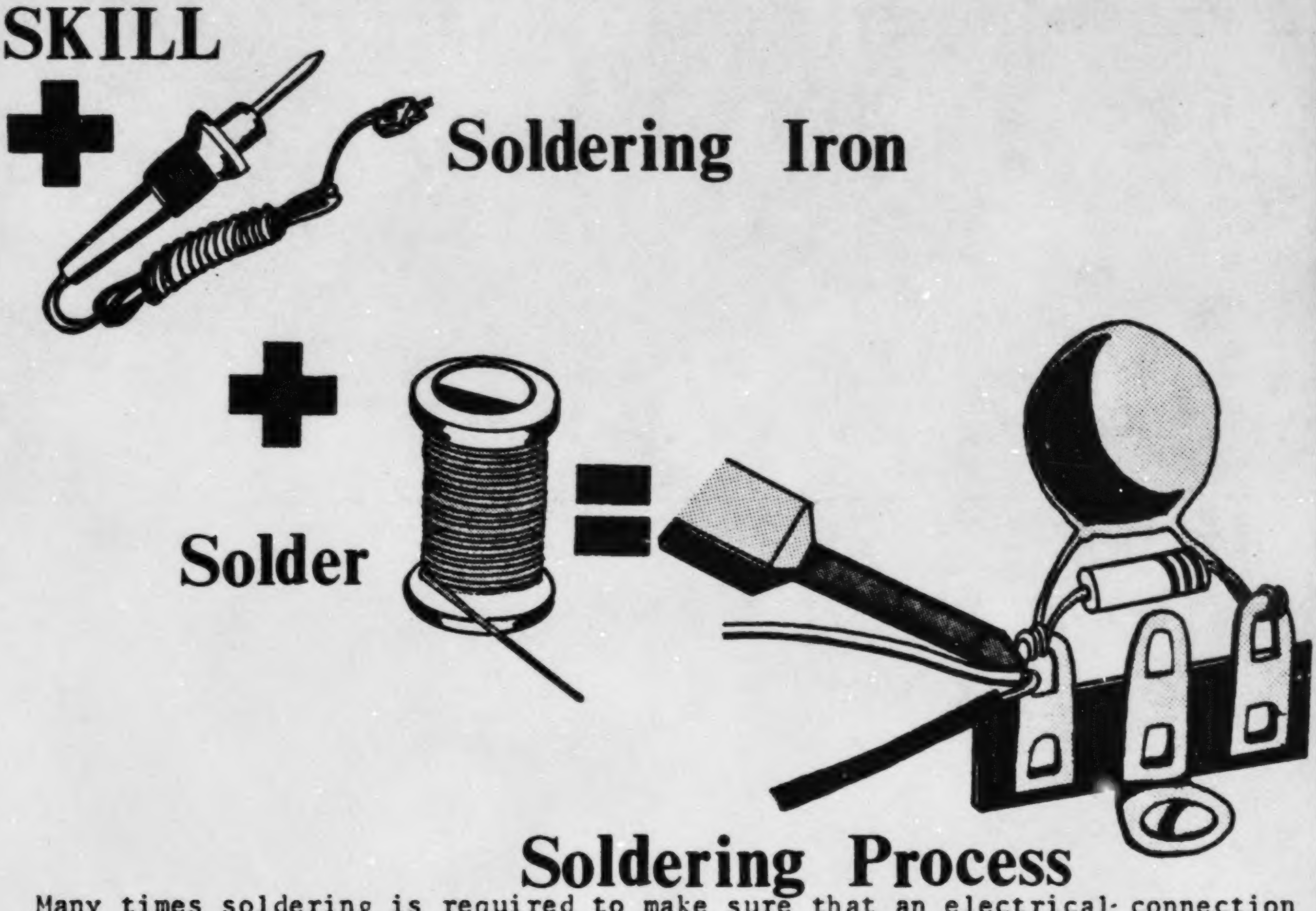
Period: ____________________

INFORMATIONAL HANDOUT

A 4 STEP GUIDE TO SOLDERING

INTRODUCTION: What is soldering?

In all Electricity/Electronics work, high quality soldering connections are important. Soldering is a process that allows the joining together, both mechanically and electrically, of metal objects (wires, component leads, etc.) through the use of a material called solder and a heating device described as a soldering iron.



Many times soldering is required to make sure that an electrical connection will last for a long time. Proper soldering will also ....

- Prevent corrosion
- Add strength

Name: ____________________

Date: ____________________

Period: ____________________

① Selecting Soldering Tools and Materials:

Always use the correct tools and materials to accomplish the task; and remember, proper use of tools and materials will increase your skill and the quality of your work. Check the following list when preparing to solder.

☐ Safety glasses
☐ Proper wattage (heat) soldering iron and tip
☐ Rosin core solder - 60/40
☐ Solder aid
☐ Solder remover tool/braid
☐ Damp sponge
☐ Misc. hand tools
☐ Bench vice

② Soldering Procedures:

Proper soldering technique requires the learning of a skill, and the best way to learn a skill is to practice. Study the list below of procedures that you should follow each time it is necessary to solder.

Obtain tools and materials
Plug iron in and clean tip
Tin the tip
Prepare parts to be soldered
Make mechanical connection
Protect heat sensitive parts
Apply solder
Don't move parts
Visual check

③ Inspection:

Check your work immediately upon completion to avoid making a poor soldering connection. Poor connections are generally caused by "three" specific problems. However, you can fix each of these problems by applying the remedies on the next page.

Name: ____________________

Date: ____________________

Period: ____________________

(SOLDERING ERROR)		(REMEDY)
● Not enough solder used	→	Apply more solder
● Too much solder used	→	Remove excess and reflow
● Improper heat application	→	Reheat and remove solder, then reflow

Desoldering Process:

Sometime you will have to remove soldered wires or parts from a chassis or printed circuit board, to do this the components must first be desoldered. Desoldering is basically the reverse action of the soldering process. Study the list below of procedures that you should follow each time you desolder.

Obtain tools and materials
Plug iron in and clean tip
Tin the tip
Keep tip damp with sponge
Grasp wire or lead
Apply heat
Apply pressure / use solder removing tool
Remove part
Visual check/clean up

SAFETY

① When "resting" a soldering iron always use a soldering iron holder or stand.

② Always hold a soldering iron by its handle and when reaching for it be alert and never accidently grab the "hot" tip.

③ Do not splash hot solder around by shaking the iron when soldering or desoldering.

Name: ______________

Date: ______________

Period: ______________

INFORMATIONAL HANDOUT

SOME GENERAL ASSEMBLY AND/OR CONSTRUCTION HINTS

Without a doubt the fastest, easiest, and most enjoyable way to develop practical electronic skills is by building a project or kit. Basic assembly and/or construction hints have been given in this handout to assist you in becoming a "super" builder. Use these suggestions when ever possible.

Chassis Wiring or Hand Wiring

- Secure wires and leads so they are positioned neatly and lay flat against chassis.
- Cut component wires to proper length before installing.
- Use insulating tubing (spaghetti) on all wires that may touch each other or could touch the chassis.
- Wrap wire around the terminal before soldering. Merely inserting the wire through the hole or slot does not make a satisfactory connection.
- As a general rule, when preparing hookup wire for connection 3/4" of the insulation should be removed from each end.
- In order to avoid breaking internal connections when stripping insulation from the leads of components, hold the lead with pliers while it is being stripped.
- The leads on components are usually longer than needed to complete the connection. Trim the lead for proper length before making the connection for soldering. As a rule, a lead should be just long enough to complete the connection.
- If the wire is stranded, make sure to twist the individual strands tightly and tin before inserting them into the terminal.
- Components should be placed in a manner that allows their value to be read without moving the part around.
- Cut off any excess component lead or wire from terminals after they have been mechanically secured.

Name: ____________________

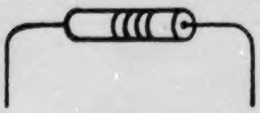
Date: ____________________

Period: ____________________

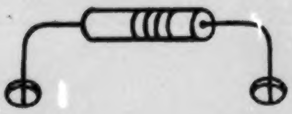
PC Component Mounting

- In wiring or soldering to printed-circuit boards, make certain there are no solder tails crossing over from one printed electrical path of copper to another.
- Avoid overheating the printed circuit copper. A soldering pencil or small iron (approximately 30 watts) is ideal for use in circuit board work.
- Holes that have been drilled on a PC board should be slightly, larger than wire or component lead to be utilized.
- PC components should be positioned flush against the circuit board when possible.
- Insert components or wire to stick out, if possible, about 1/16 to 3/32 of an inch on copper side then bend flat and solder. Watch out, don't use to much heat when soldering!
- A simple procedure, that improves the overall looks of your PC board, is to position all resistors so their coded value can easily be read in a glance from left to right.

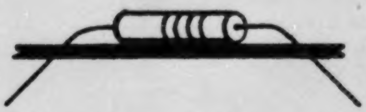
DETAIL VIEW OF COMPONENT MOUNTING ON PC BOARD



1. BEND LEADS

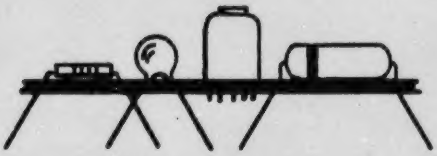


2. INSERT LEADS THROUGH PROPER HOLES FROM NONCOPPER SIDE OF PRINTED CIRCUIT BOARD



3. POSITION COMPONENT NEXT TO PRINTED CIRCUIT BOARD AND BEND LEADS TO HOLD IN PLACE

4. PROPER PLACEMENT



SAFETY

Remember, safety is of prime concern during all aspects of the building process. GOOD LUCK!

Name: ____________________

Date: ____________________

Period: ____________________

INFORMATIONAL HANDOUT

ELECTRICAL CONNECTIONS

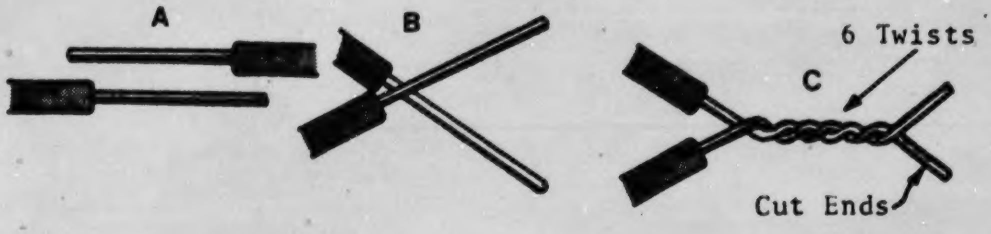
Electrical connections and electrical circuits must be reliable, and part of this reliability requires the individual who is wiring and soldering to be skillful. Use these sheets to help you master some basic wiring techniques, but remember it takes a great deal of practice to learn a skill, so lets get started!

Note, making hand-formed wire connections are called splices, the three most commonly used are as follows: Rat-Tail, Tap or Tee, and the Western Union.

3 Common Splices

Rat-Tail:

This splice is generally used where wires are to be joined together. The Rat-Tail joint is commonly placed or used in an electrical junction box, like the ones in your home. This splice should be soldered and taped, or a solderless connector (wire nut) used, before the box cover is replaced. Note, if wire sizes below AWG 14 are used the splice can no longer be formed by hand. Use pliers for twisting and be carefull not to damage the wires. Follow the examples below when making this splice.



....................then solder and tape.

Tap or Tee:

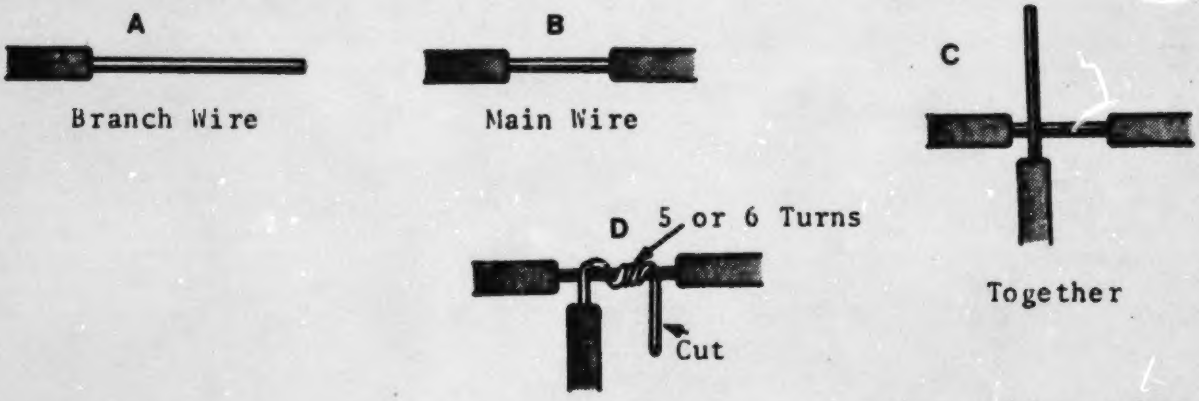
This splice is also used primarily in home electrical wiring circuits. The Tap splice is used when you want to connect a branch conductor to one wire that "runs through" a junction box. The advantage of this splice

Name: ____________________

Date: ____________________

Period: ____________________

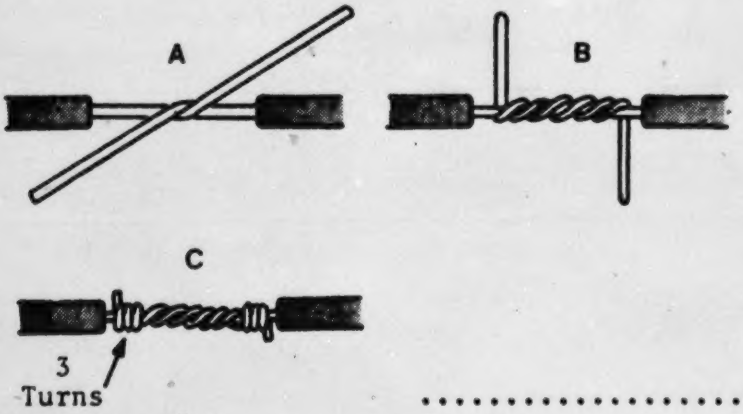
is that the main wire is not cut, just stripped where the branch wire is joined. This splice should be soldered and taped, before the box cover is replaced. Follow the examples given when making this splice.



...................then solder and tape.

Western Union:

This splice is the strongest of the three presented here and the most interesting one to make. It is used for splicing a broken/cut wire in a long wire or to extend a wire a few more feet if it is short. This splice should be soldered and taped when completed. This splice has a unique piece of history attached to its name. When the Western Union Telegraph Company had problems with breaks in telegraphic wires their workers would use this splice to repair the wire.



...................then solder and tape.

Solderless Connectors

Wire Nuts:

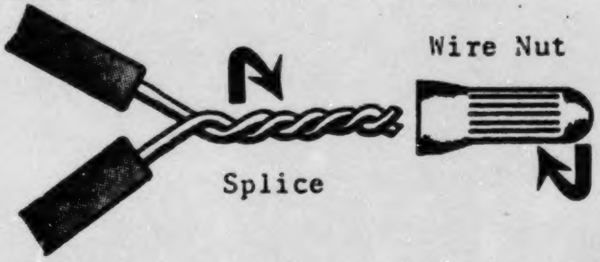
Solderless connectors or wire nuts can be used generally to splice wires up to size #6 AWG. The most common solderless connectors are the twist-on variety. This electrical hardware item is handy when one does not

Name: ______________________

Date: ______________________

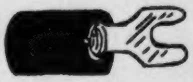
Period: ______________________

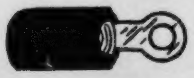
have the opportunity to solder or when the need of a quick yet strong mechanical electrical connection is necessary. Follow the example below when using this kind of connector.



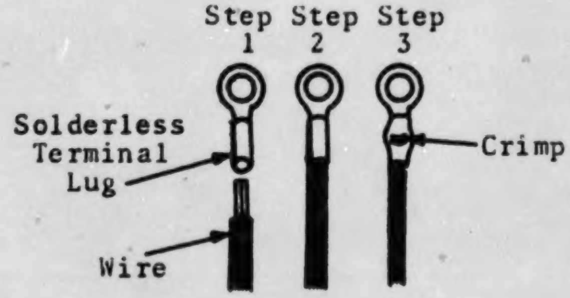
Solderless Terminal Lugs:

Solderless or crimp type terminals are used sometimes in projects as a means to provide a strong metal-to-metal bond (terminal-to-wire) without the use of the soldering process. Two common types are generally used, they are the Fork and Ring tongue styles.

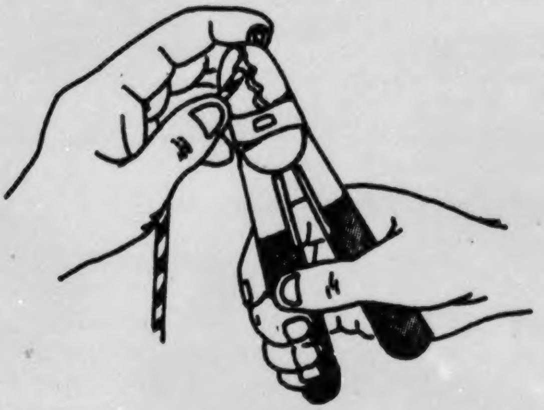

Fork Tongue


Ring Tongue

The style selected depends on your specific use, and to connect either one to wire requires a crimping tool. Check the example below for proper instalation technique.



Step 3 utilizes this kind of crimping tool



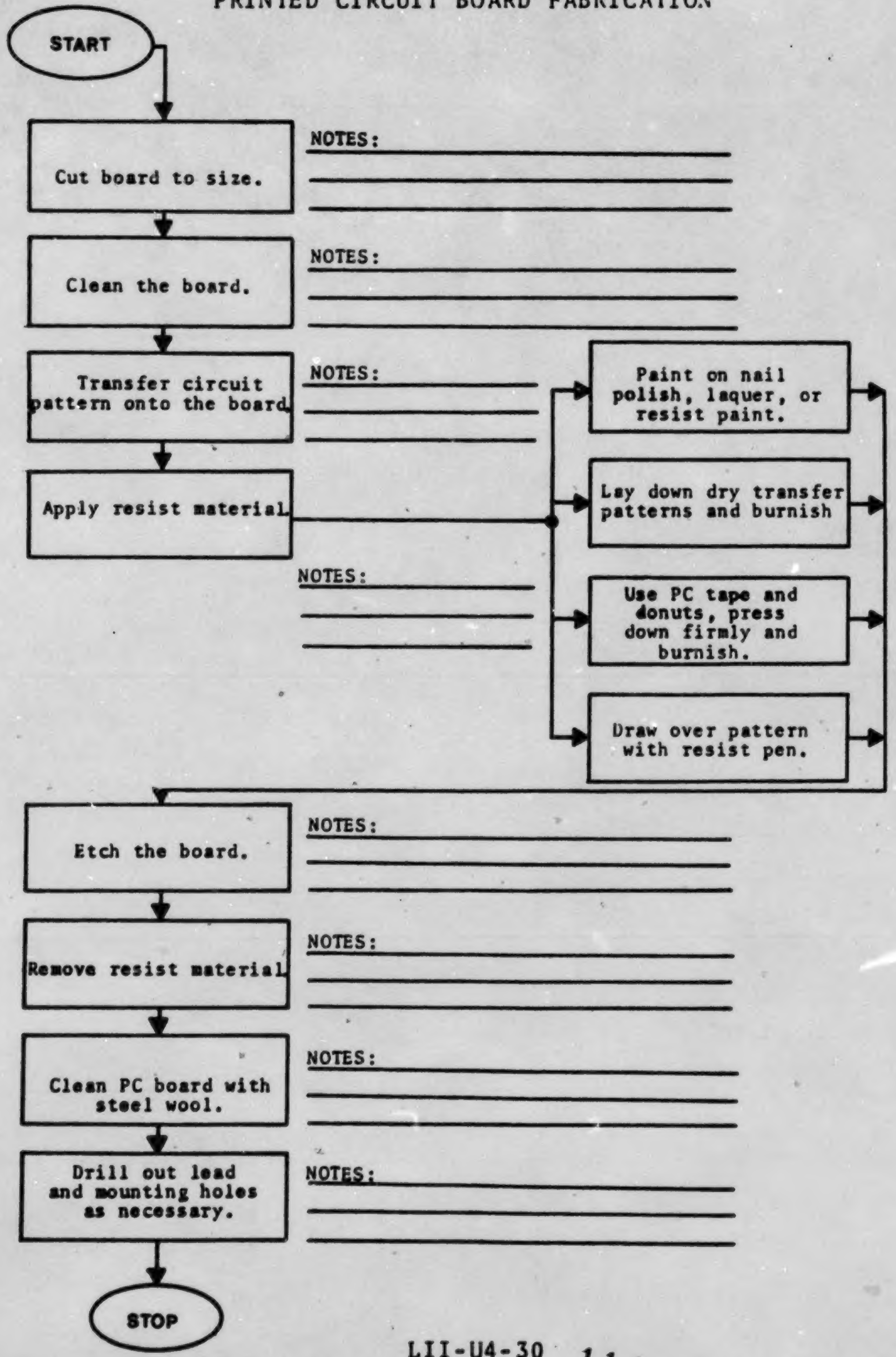
Name: ____________________

Date: ____________________

Period: ____________________

INFORMATIONAL HANDOUT

PRINTED CIRCUIT BOARD FABRICATION

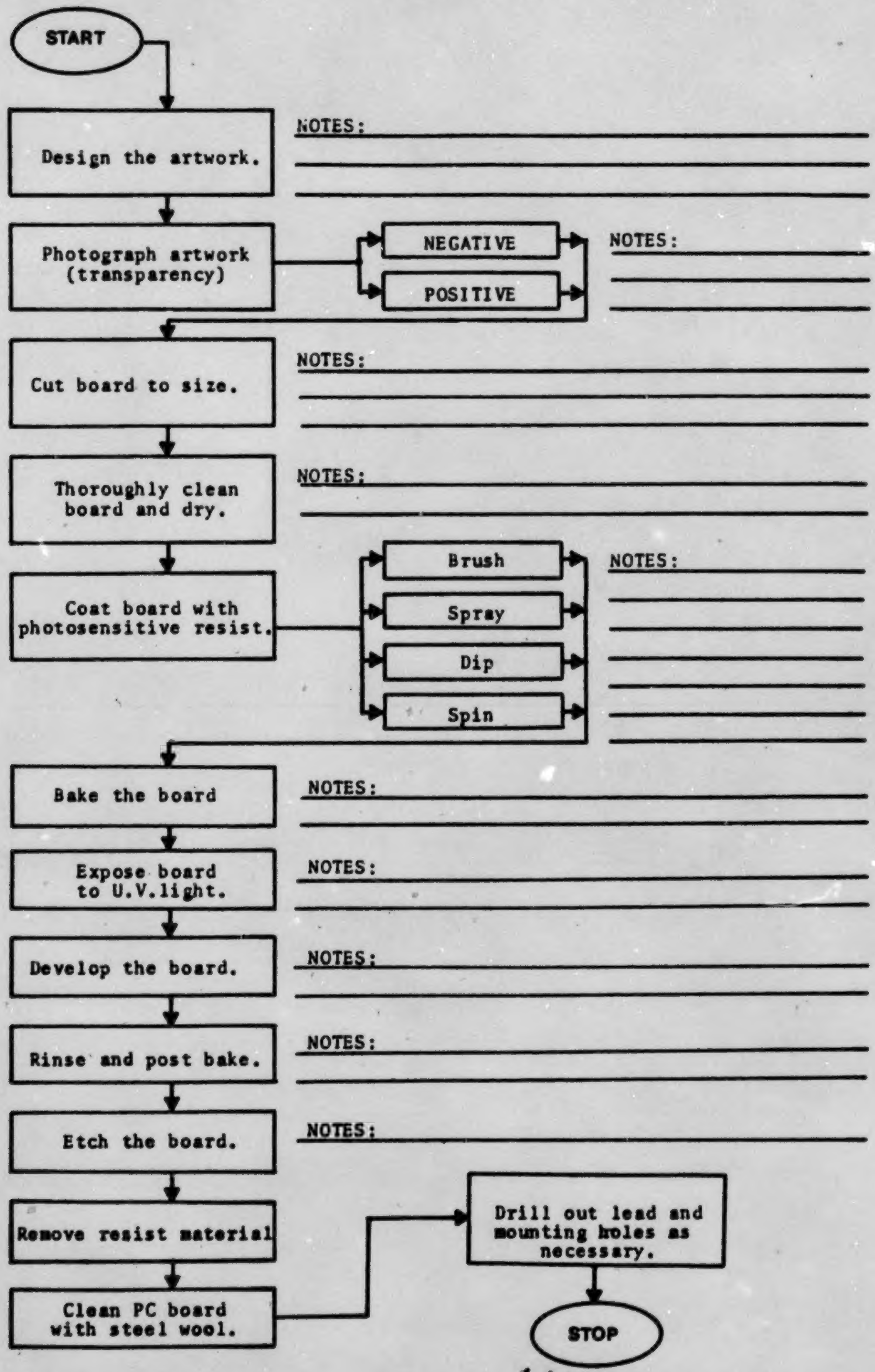

START
Cut board to size.
NOTES:
Clean the board.
NOTES:
Transfer circuit pattern onto the board
NOTES:
Apply resist material
NOTES:
Paint on nail polish, laquer, or resist paint.
Lay down dry transfer patterns and burnish
Use PC tape and donuts, press down firmly and burnish.
Draw over pattern with resist pen.
Etch the board.
NOTES:
Remove resist material
NOTES:
Clean PC board with steel wool.
NOTES:
Drill out lead and mounting holes as necessary.
NOTES:
STOP

Name: ____________________

Date: ____________________

INFORMATIONAL HANDOUT Period: ____________________

PRINTED CIRCUIT BOARD FABRICATION - PHOTOGRAPHIC METHOD


START
Design the artwork.
NOTES:
Photograph artwork (transparency)
NEGATIVE
POSITIVE
NOTES:
Cut board to size.
NOTES:
Thoroughly clean board and dry.
NOTES:
Coat board with photosensitive resist.
Brush
Spray
Dip
Spin
NOTES:
Bake the board
NOTES:
Expose board to U.V.light.
NOTES:
Develop the board.
NOTES:
Rinse and post bake.
NOTES:
Etch the board.
NOTES:
Remove resist material
Clean PC board with steel wool.
Drill out lead and mounting holes as necessary.
STOP

SCORE:

GRADE:

Name: ____________________

Date: ____________________

Period: ____________________

PROJECT EVALUATION SHEET

Project ____________________ Construction Dates ____________ To ____________

	Excellent	Good	Average	Poor	Offensive
FINISH- (paint labeling, etc.)					
ASSEMBLY (techniques and quality)					
LAYOUT AND DIMENSIONS					
TOOL USAGE					
DESIGN (form/function)					
MATERIALS USED TO BEST ADVANTAGE					
GOOD USE OF TIME					
WORK HABITS					
PROJECT REPORT					
COMMENTS					

SCORE:

GRADE:

Name: ____________________

Date: ____________________

Period: ____________________

ANSWER SHEET

EXAM LII U4

	T A	F B	C	D		T A	F B	C	D		T A	F B	C	D		T A	F B	C	D
1.		■			26.					51.					76.				
2.		■			27.					52.					77.				
3.	■				28.					53.					78.				
4.	■				29.					54.					79.				
5.	■				30.					55.					80.				
6.		■			31.					56.					81.				
7.		■			32.					57.					82.				
8.		■			33.					58.					83.				
9.	■				34.					59.					84.				
10.	■				35.					60.					85.				
11.		■			36.					61.					86.				
12.		■			37.					62.					87.				
13.	■				38.					63.					88.				
14.	■				39.					64.					89.				
15.	■				40.					65.					90.				
16.		■			41.					66.					91.				
17.	■				42.					67.					92.				
18.	■				43.					68.					93.				
19.		■			44.					69.					94.				
20.		■			45.					70.					95.				
21.	tinning				46.					71.					96.				
22.	rosin flux				47.					72.					97.				
23.	conductor joint/ splice				48.					73.					98.				
24.	heat sink				49.					74.					99.				
25.	clean				50.					75.					100.				

*Show work for problems on back of answer sheet.

ANSWER KEY
UNIT 4

A. TOOL AND HARDWARE IDENTIFICATION

1. file
2. center punch
3. electric hand drill
4. hack saw
5. Phillips head screwdriver
6. long nose plier
7. wire stripper
8. diagonal plier
9. drill bit
10. ball peen hammer
11. bench vise
12. drill press
13. adjustable wrench
14. Greenlee chassis punch
15. shear
16. slip joint plier
17. lineman's plier or electrician's plier
18. nut driver
19. standard screwdriver
20. soldering iron
21. open end wrench
22. box pan brake
23. reamer
24. printed circuit board
25. chassis
26. wire tie
27. Whitney hand punch
28. desoldering tool
29. solder
30. solderless or crimp type
31. stranded wire
32. heat sink
33. wire nut
34. metal shear

B. SOLDERING, SPLICES, AND PC FABRICATION

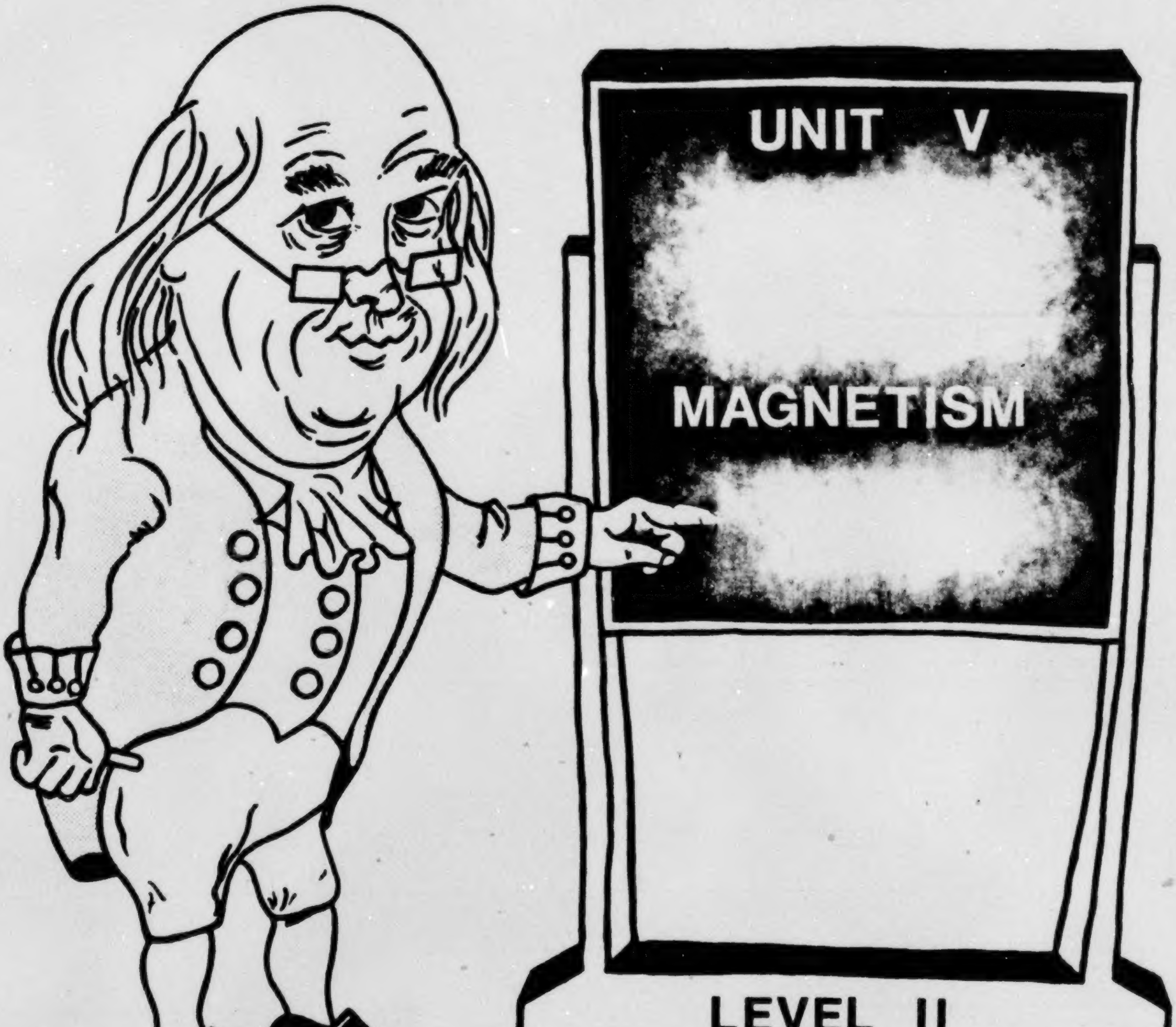
(subjective evaluation)

C. QUEST ACTIVITY

(subjective evaluation)

ELECTRICITY / ELECTRONICS

CURRICULUM GUIDE
INSTRUCTIONAL MODULE


UNIT V
MAGNETISM
LEVEL II

STATE OF CALIFORNIA
DEPARTMENT OF EDUCATION

NAME________________________
DATE STARTED_____________
DATE COMPLETED__________

BY
R. E. LILLO
N. S. SOFFIOTTO

Title of Unit: Magnetism

Time Allocation: 2 weeks

Unit Goal:

To broaden and impart greater student competence in terms of evaluating the effects and influence magnetism has on our lives, and to discover the inseparable relationship to electricity that it enjoys.

Unit Objectives:

The student will be able to:

1. state the properties of magnetism and list ten electrical or electronic devices which utilize magnetism in one form or another.
2. identify the characteristics of magnetic lines of flux, and when given a magnet with the pole polarity labeled, indicate the direction of the lines of flux, both internal and external.
3. explain the basic laws of magnetism related to the poles of a magnet, and describe the earth's magnetism in reference to its geographical poles.

Evaluation:

The student will demonstrate his/her competence in terms of these measurable objectives based upon individual instructors acceptable performance criteria, which may utilize a combination of written, oral and laboratory testing procedure.

Instructor References:

Electricity and Electronics. Howard Gerrish and William Dugger, Goodheart-Willcox Co., 1978. Chapter: 4

Industrial Arts Electricity. Clifford Lush and Glenn Engle, Chas. A. Bennett Co., 1971. Chapter: 2.

Introduction to Electricity. Kurt Harding Schick, McGraw-Hill Ryerson Limited, 1975. Chapter: 2.

Overview:

Note, in this unit several important fundamental competencies are presented as a foundation for several other units within this level, and for succeeding units in more advanced levels.

Most students can identify some of the basic properties of magnets through their own personal experiences, hence the subject matter is not foreign and quite easy to introduce.

Stress the vast influence that this topic has on the lives of each of us, and then trace the historical background of this topic prior to the technical presentation.

The next topic of emphasis should be the basic laws of magnetic attraction and repulsion, and while instructing in this area a discussion in reference to the earth's magnetism would be appropriate.

A variety of exercises and laboratory experiments and/or projects should be coordinated with all unit topics when feasible.

Suggested Presentation Hints/Methodology:

Follow the instructional module unit outline as a basic skeleton for curriculum presentation, however, note the following:

1. When demonstrating magnetic lines or flux with a magnet and iron filings be careful not to use an excessively strong magnet. Too intense of a magnet will not perform adequately because it forces the filings into groups rather than a uniform pattern.
2. To obtain inexpensive magnets for classroom demonstrations, consider government surplus stores as a prime vendor. Usually, this kind of merchandise can be purchased at a rate far below that of commercial distributors. If it is more convenient, locate a livestock supply house or a dairy person, who utilizes bar magnets for their cattle's protection. Make a point to ask them for any discarded magnets. Note, cows are sometimes given a small bar magnet to swallow in order to protect their inner stomaches from foreign objects which have been accidently consumed.
3. When discussing temporary magnets and their characteristics, many instructors will describe electromagnets as the major subcategory. Many electromagnets can and should be demonstrated along with inexpensive devices such as relays, electric bells, and solenoids.

Supplemental Activities and Demonstrations:

1. If a limited budget necessitates simplistic laboratory experiences, then a natural for this unit would be to have students build a simple electric motor kit. This kind of motor is generally designed for beginning kit builders and sold complete with a manual that includes information regarding the How and Why of its operation.
2. When demonstrating magnetic principles, place a magnet or magnets on the stage plate of an overhead projector and then cover with a clear plastic sheet. Using a shaker, sprinkle some iron filings on top of the sheet and discuss the pattern created. This can also provide an opportune time to discuss magnet polarity and the basic law of magnetism.

Instructional Module Contents:

1. Unit Outline (overhead)
2. Pre-Post Test (keyed)
3. Technical Glossary
4. Worksheet (vocabulary) - Word Decoding
5. Quest Activities
6. Informational Handout (Classification of Magnets)
7. Informational Handout (Magnetism and Magnetic Fields)
8. Unit Module Answer Keys

V. Magnetism

A. Magnetic Force

B. Early Use of Magnets

C. Types of Magnets

D. Lines and Fields of Magnetic Force
    1. Basic law of magnetism

    2. The poles of a magnet

E. Earth's Magnetism

F. Compass Usage

G. Magnetic and Nonmagnetic Materials

H. Magnetism and How it is Related to Electricity
    1. Uses in daily life

I. Magnetizing and Demagnetizing

Test Number _____

LII-U5

UNIT EXAM

MAGNETISM

IMPORTANT-

Indicate your responses on the answer sheet only. Fill in the box corresponding to the correct answer to each question - there is only one correct answer for each question.

1. Copper, aluminum, and steel are magnetic materials. (T-F)

2. A permanent magnet is one that cannot be destroyed or weakened. (T-F)

3. It is never necessary or desirable to demagnetize a material or object. (T-F)

4. Alnico is a natural magnet. (T-F)

5. Most metalic materials exhibit magnetic properties. (T-F)

6. As magnetic poles are moved apart, the magnetic force of attraction or repulsion decreases. (T-F)

7. Heating, striking, or placing a magnet within an alternating current field will increase its magnetic strength. (T-F)

8. Magnetic flux lines "flow", or extend from the N-pole to the S-pole. (T-F)

9. The earth's magnetic field is similar to the field developed by a bar magnet. (T-F)

10. The needle of a compass points toward the earths geographic north pole. (T-F)

11. Surrounding each magnet is:
(A) a negative charge, (B) a current, (C) a voltage, (D) a magnetic field.

12. A magnet which keeps its magnetism for only a short time is: (A) a permanent magnet, (B) made of soft iron, (C) a temporary magnet, (D) both B and C.

13. A magnetic field is thought to be made up of: (A) N or S poles, (B) orbiting electrons, (C) flux lines, (D) glass

14. The basic law of magnetism states: (A) unlike poles repel, (B) like poles repel, (C) two south poles attract, (D) like poles attract.

15. As you move away from the poles of a magnet, the density of the flux lines: (A) decreases, (B) increases, (C) is unchanged, (D) may increase or decrease depending upon the magnet.

16. In the process of magnetizing a piece of steel, the magnetic __________ within the material are aligned in one direction.

17. Which of the following is not a permanent magnet material? (A) steel, (B) soft iron, (C) alnico, (D) iron/cobalt.

18. Which pole of a magnet has the most magnetic strength? (A) N-pole, (B) S-pole, (C) both poles have equal strength, (D) will vary from one magnet to the next.

19. Which of the following operates by magnetism or magnetic force? (A) electric motor, (B) electric buzzer, (C) solenoid, (D) all of the above.

20. Other than magnetic stroking, a steel bar can be magnetized by: (A) placing it within an AC field, (B) striking it, (C) heating it, (D) placing it within a DC field.

21. The point of a magnet, where the magnetic force is most concentrated is called a __________.

22. A north magnetic pole will attract a __________ magnetic pole.

23. The first permanent magnets were composed of an iron ore called __________ or lodestone.

24. Materials that are attracted to a magnet, or exhibit magnetic characteristics are called __________ materials.

25. Electromagnets are actually a type of __________ magnet.

Name: ____________________

Date: ____________________

Period: ____________________

TECHNICAL GLOSSARY

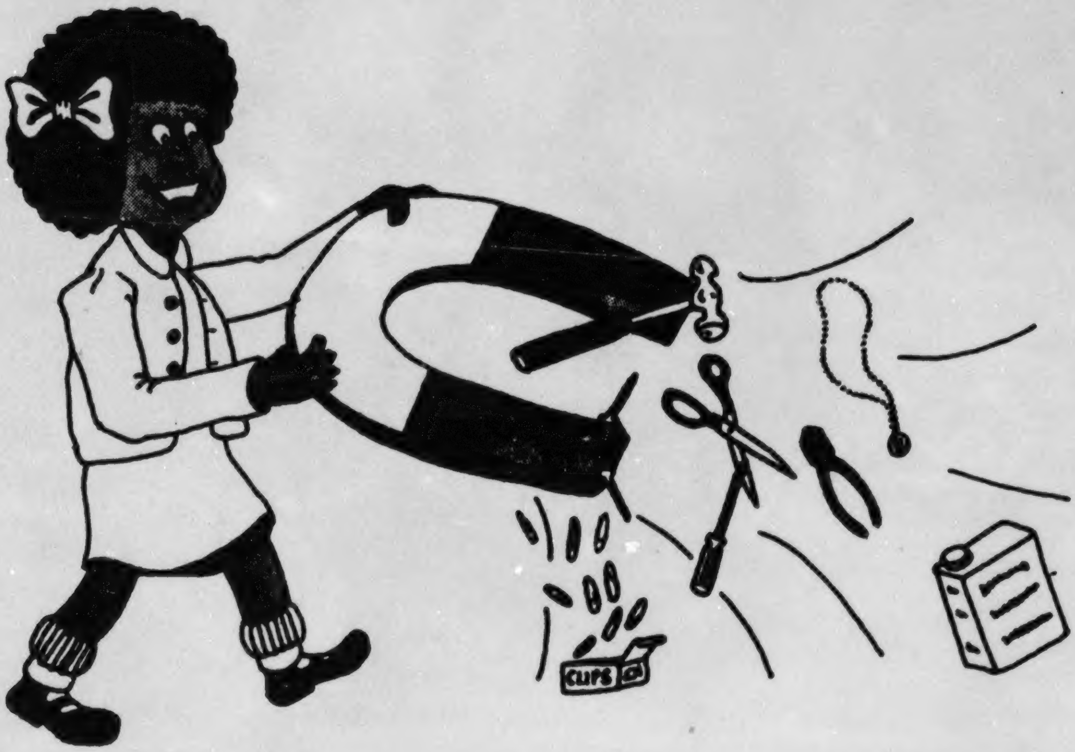
ATTRACT:	The process of drawing or pulling toward an object. For example; a magnet will attract a piece of soft iron.
BASIC LAW OF MAGNETISM:	A law that explains the interaction of magnetic fields. The law states: Like poles repel and unlike poles attract
COMPASS:	A device which utilizes the earth's magnetic field, and a pivoted magnet needle to indicate direction.
FERROMAGNETIC MATERIAL:	A classification for materials which are attracted by a magnet. These magnetic materials include iron, nickel, cobalt, etc.
FLUX LINES:	The lines of magnetic force which exist around a magnet.
GEOGRAPHIC POLE:	The axis points of the earth, such as the geographic south pole.
KEEPER:	A piece of soft iron placed across the poles of a magnet to confine the magnetic field within the magnet, and to avoid demagnetizing.
MAGNET:	A piece of iron, or a special alloy, which exerts an invisible force of attraction on materials such as iron, nickel, or cobalt.
MAGNETIC FIELD:	The space around a magnet which is influenced or affected by its magnetic force.
MAGNETIC NORTH POLE:	One of the earth's two magnetic poles. The earth's magnetic north pole is located approximately 1,000 miles south of the geographic north pole in northern Canada. The magnetic south pole is actually some 1,500 miles from the geographic south pole on the continent of Antartica.
MAGNETIC POLE:	The portion of a magnet where the lines of force are most concentrated. In every magnet there is one north-seeking pole (N-pole), and one south seeking pole (S-pole)
MAGNETIC SHIELD:	A magnetic material used to route magnetic lines of force around an object. This prevents the object from being affected by the magnetic field.
MAGNETISM:	The invisible force, exerted by a magnet, that allows it to attract ferromagnetic materials, and to attract or repell other magnets or magnetic fields.
MAGNETITE:	A blackish iron ore which in its natural state contains magnetic particles within the material. Once these particles are aligned, the material will become magnetic and attract other ferromagnetic materials.

Name: ____________________

Date: ____________________

Period: ____________________

NATURAL MAGNET:	A material, such as "lodestone" or "magnetite," which in its natural state exhibits the qualities of a magnet.
PERMANANENT MAGNET:	A man-made magnet which when magnitezed will retain its magnetism. Steel or alnico are examples of material which can be made into permanent magnets.
REPEL:	The process of pushing away or forcing back of an object. A north pole of a magnet will repel the north pole of a second magnet.
TEMPORARY MAGNET:	A man-made magnet that loses its magnetism soon after the magnetizing force is removed. Magnetized soft iron is an example of a temporary magnet.



SCORE:
GRADE:

Name: ____________

Date: ____________

Period: ____________

WORKSHEET

VOCABULARY WORD DECODING

The words below have little meaning until they are decoded. Each letter actually represents another letter in the alphabet. Your task is to break the code and decode each word. The example will get you started by providing three decoded letters. The code remains the same throughout the worksheet.

EXAMPLE: A.	G E D M A N	A.	MAN
1.	G E Z D S I _ _ _ _ _ _	1.	
2.	G E Z D S I T N G _ _ _ _ _ _ _ _ _	2.	
3.	L A G C E N N _ _ _ _ _ _ _	3.	
4.	E R R K E L R _ _ _ _ _ _ _	4.	
5.	K S C S J _ _ _ _ _	5.	
6.	M S S C S K _ _ _ _ _ _	6.	
7.	D A K R W _ _ _ _ _	7.	
8.	C S K G E D S D R _ _ _ _ _ _ _ _ _	8.	
9.	V S K K A G E Z D S R T L _ _ _ _ _ _ _ _ _ _ _ _ _	9.	
10.	G E Z D S R T R S _ _ _ _ _ _ _ _ _	10.	
11.	R S G C A K E K P _ _ _ _ _ _ _ _ _	11.	
12.	G E Z D S R T L N W T S J O _ _ _ _ _ _ _ _ _ _ _ _ _ _	12.	

SCORE:

GRADE:

Name: ____________________

Date: ____________________

Period: ____________________

WORKSHEET

QUEST ACTIVITY

"UNIT 5"

MATCHING

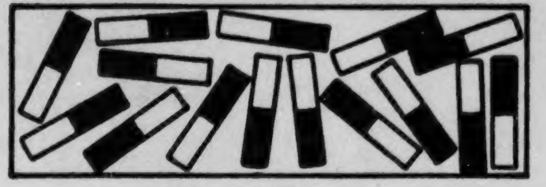
Match the term with the appropriate statement.

1. Lodestone
2. Compass
3. Repel
4. Ferromagnetic Material
5. Magnetizing
6. Attract
7. Magnetic Field
8. Magnetic Shield
9. Demagnetizing
10. Temporary Magnet

A. A suspended magnetic needle.
B. The total area around a magnet which contains flux lines.
C. Two N-poles brought close together.
D. Electromagnet or soft iron.
E. A natural magnet.
F. Nickel
G. Striking or heating a magnet.
H. One N-pole and one S-pole brought close together.
I. A soft iron material used to route flux lines around an object.
J. Drawing a permanent magnet along a steel bar.

1. ☐
2. ☐
3. ☐
4. ☐
5. ☐
6. ☐
7. ☐
8. ☐
9. ☐
10. ☐

11. The drawing below shows an unmagnetized steel bar. Using the area provided, make a sketch showing the change in position of the "magnetic molecules" to form a magnetized piece of steel.

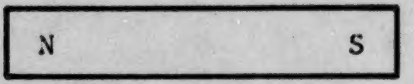


Name: ____________________

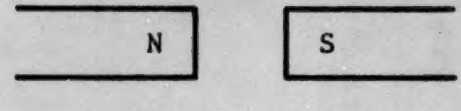
Date: ____________________

Period: ____________________

12. Draw a sketch of the magnetic field which surrounds the bar magnet below.

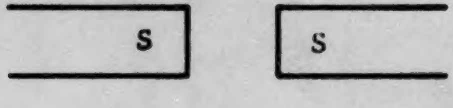


13. Draw a sketch of the field produced by the two magnets below.



Does this field produce attraction or repulsion?

14. Draw the field produced by the two magnets pictured below.



Does this field produce a force of attraction or repulsion?

15. List three practical uses for magnets or magnetic fields.

1.

2.

3.

Name: ____________________

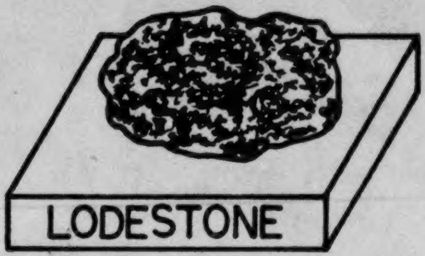
Date: ____________________

Period: ____________________

INFORMATIONAL HANDOUT

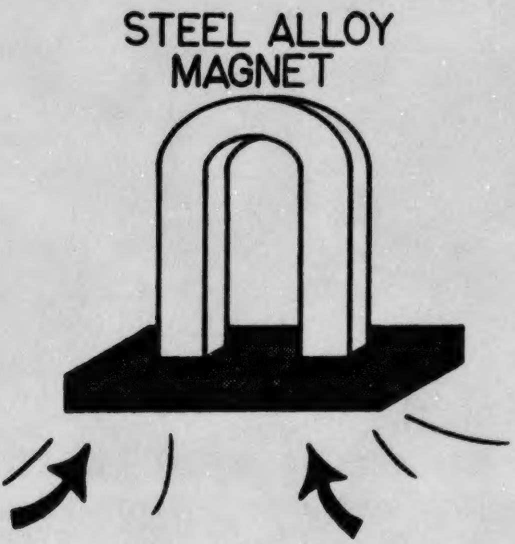
CLASSIFICATION OF MAGNETS

Any magnet can be classified as either natural, temporary, or permanent. Study each classification described below and the corresponding description.



NATURAL

A natural magnet needs no special treatment by people to make it magnetic. Lodestone (or magnetite) is a natural magnet found on the earth. Especially large quantities can be found in the United States, however, these magnets are very weak and really serve little purpose in the modern world.



PERMANENT

A permanent magnet keeps its magnetism for a long time. This type of magnet is produced from magnetic materials and can be made in a wide variety of shapes and sizes. They are used frequently in electrical appliances, hardware items, and compasses. The term artificial magnets is sometimes used to describe either permanent or temporary magnets, but what it really means is that the magnet is "man made."

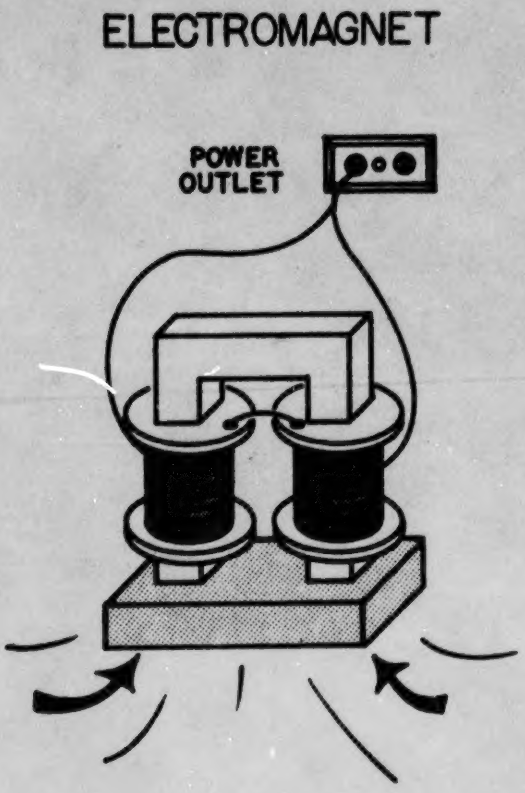
Name: ____________________

Date: ____________________

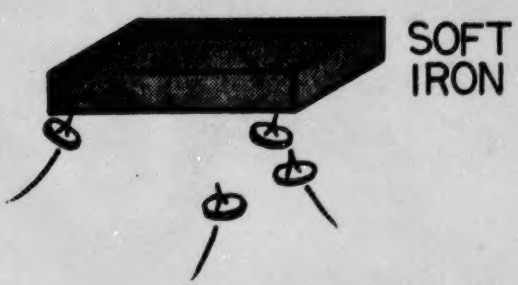
Period: ____________________

TEMPORARY

Temporary magnets are generally of two varieties, those made of material that do not keep their magnetism long (soft iron), and those which operate with the help of electricity (electromagnets). Electromagnets are temporary in that when electricity is applied they act like a magnet however, when the electricity is removed they do not retain their magnetism.



OR



Name: ______________________

Date: ______________________

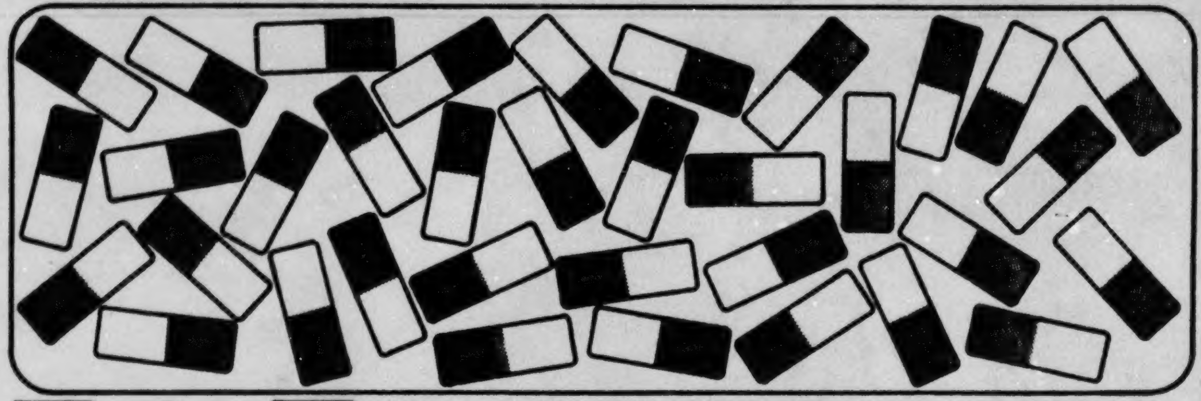
Period: ______________________

INFORMATIONAL HANDOUT

MAGNETISM AND MAGNETIC FIELDS

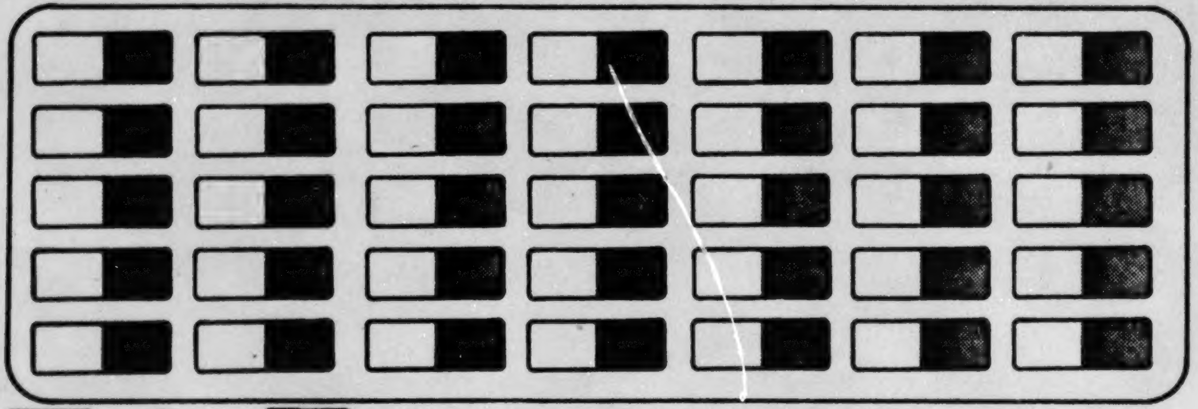
THE PHYSICS OF MAGNETIC MATERIALS:

Only certain materials have the ability to be magnetized, or to be attracted by a magnetic field. Natural magnetic materials are called ferromagnetic materials and include the elements iron, nickel, and cobalt. The atoms of these three materials have the peculiar ability to orient themselves so that each atom has a definite positive and negative side. These atoms combine to form magnetic molecules or domains, each small molecule has a north and south pole. In an unmagnetized piece of iron, for example, these magnetic molecules arrange themselves in a random pattern as shown below.



□=S ■=N **UNMAGNETIZED IRON**

When a material is magnetized, either by contact, or by being placed within a DC electromagnetic field, the magnetic molecules are forced to move and align themselves in one direction as shown below.



□=S ■=N **MAGNETIZED IRON**

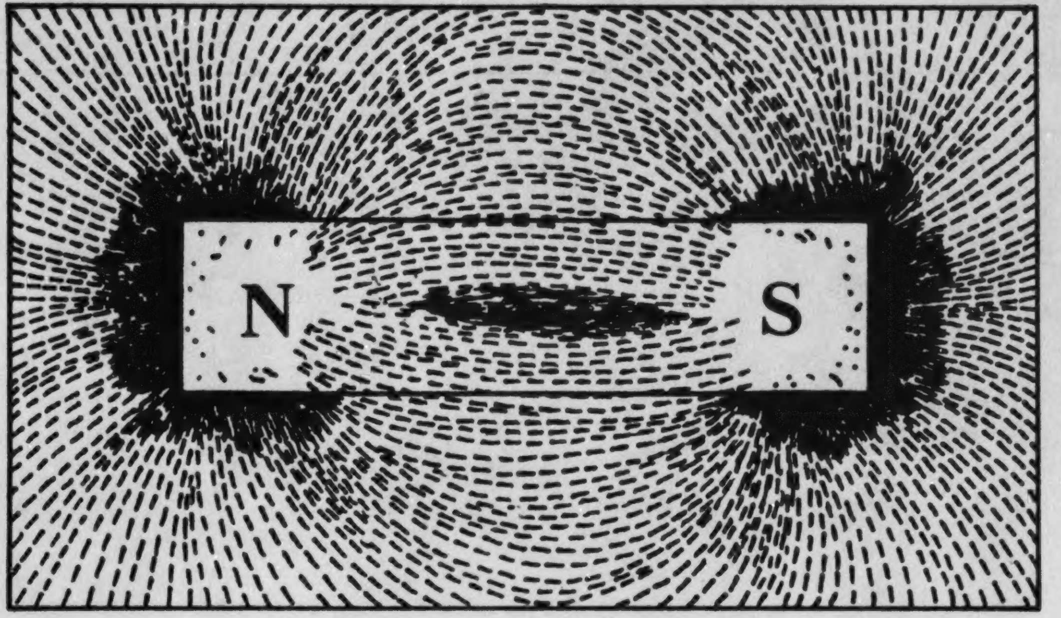
Name: ____________________

Date: ____________________

Period: ____________________

MAGNETIC FIELDS:

The magnetic field of a magnet is made up of a number of invisible lines of force known as flux lines. These flux lines extend from the magnetic poles out into space, flowing from the N-pole to the S-pole, and not crossing or touching. As the distance from the magnet increases, the separation between the flux lines becomes greater, and the field becomes weaker. The strongest concentration of flux lines is located at the poles of the magnet. Study the diagram of the bar magnet and its associated magnetic field below. Locate the magnetic poles, and the areas of dense flux concentration.



Magnetic Field

NOTES:

Name: ____________________

Date: ____________________

Period: ____________________

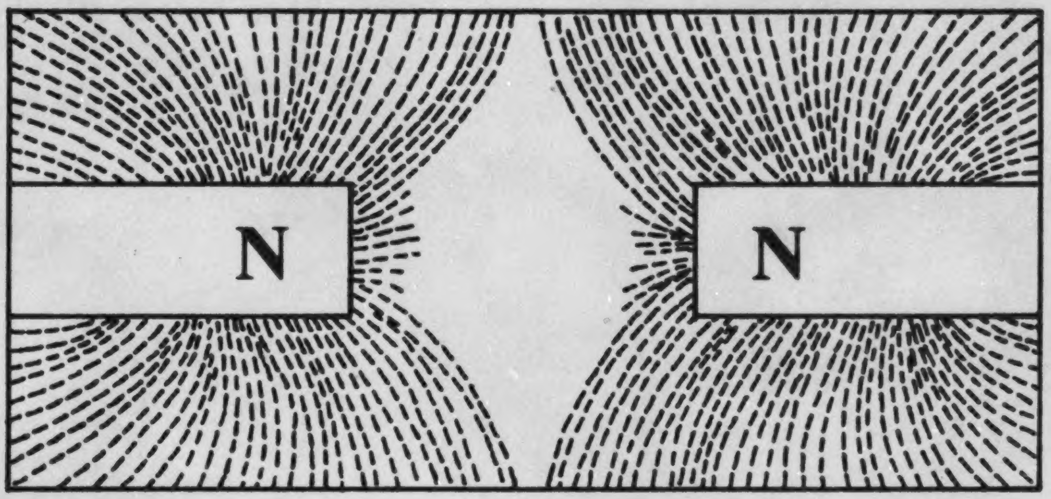
BASIC LAW OF MAGNETISM:

As you probably know from common experience, when two magnets are brought close to each other they will either pull together (attract), or push apart (repel). The action of the two magnets will depend upon the orientation of the magnetic poles. The basic law of magnetism explains the magnetic reaction in this way:

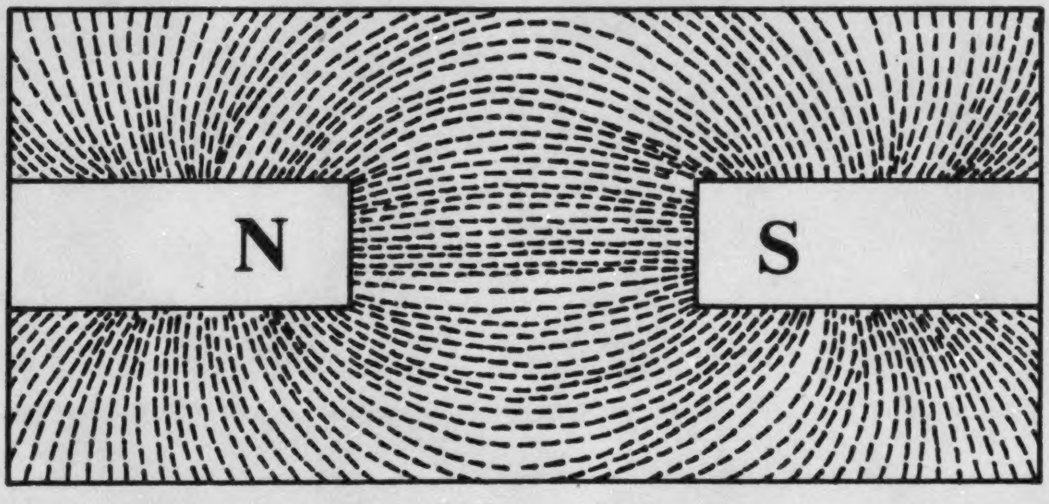
Like poles repel - (N-pole and N-pole repel as well as S-pole and S-pole)

Unlike poles attract - (N-pole and S-pole attract)

Fields of magnetic attraction and repulsion are shown below:



Magnetic Repulsion



Magnetic Attraction

SCORE:

GRADE:

Name: ____________________

Date: ____________________

Period: ____________________

ANSWER SHEET

EXAM LII U5

	T	F				T	F				T	F				T	F		
	A	B	C	D		A	B	C	D		A	B	C	D		A	B	C	D
1.		■			26.					51.					76.				
2.		■			27.					52.					77.				
3.		■			28.					53.					78.				
4.		■			29.					54.					79.				
5.		■			30.					55.					80.				
6.	■				31.					56.					81.				
7.		■			32.					57.					82.				
8.	■				33.					58.					83.				
9.	■				34.					59.					84.				
10.	■				35.					60.					85.				
11.				■	36.					61.					86.				
12.				■	37.					62.					87.				
13.			■		38.					63.					88.				
14.		■			39.					64.					89.				
15.	■				40.					65.					90.				
16.	domains/molecules				41.					66.					91.				
17.		■			42.					67.					92.				
18.			■		43.					68.					93.				
19.				■	44.					69.					94.				
20.				■	45.					70.					95.				
21.	pole				46.					71.					96.				
22.	south				47.					72.					97.				
23.	magnetite				48.					73.					98.				
24.	ferromagnetic				49.					74.					99.				
25.	temporary				50.					75.					100.				

*Show work for problems on back of answer sheet.

ANSWER KEY
UNIT 5

A. WORD DECODING

1. magnet
2. magnetism
3. compass
4. attract
5. repel
6. keeper
7. north
8. permanent
9. ferromagnetic
10. magnetite
11. temporary
12. magnetic shield

B. QUEST ACTIVITY

1. E
2. A
3. C
4. F
5. J
6. H
7. B
8. I
9. G
10. D
11. line up small magnets horizontally, all dark ends pointing in the same direction.
12. (subjective answer)

13. (subjective answer)

    attraction

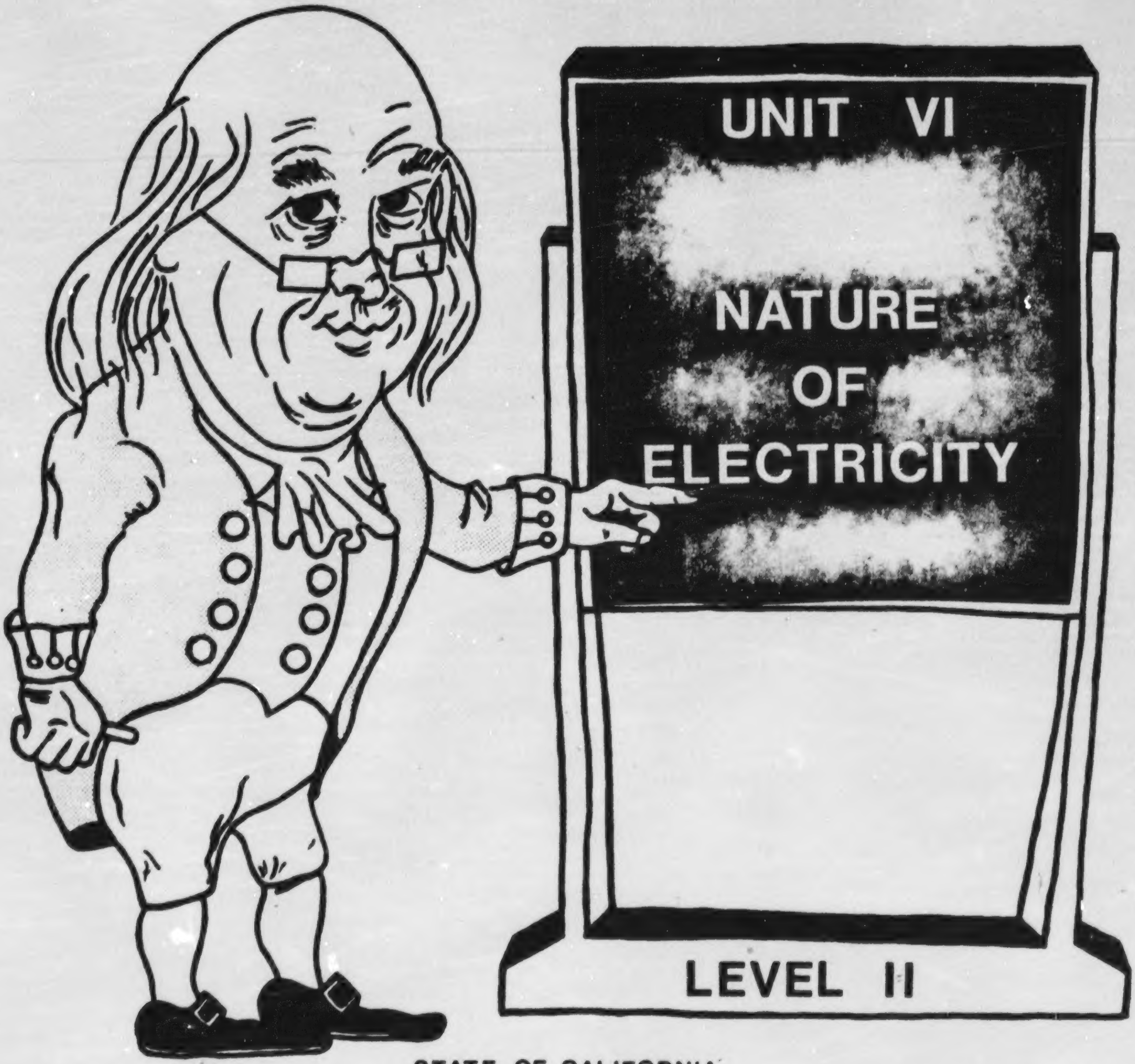
14. (subjective answer)

    repulsion

15. (subjective answer)

ELECTRICITY / ELECTRONICS

CURRICULUM GUIDE
INSTRUCTIONAL MODULE


UNIT VI
NATURE OF ELECTRICITY
LEVEL II

STATE OF CALIFORNIA
DEPARTMENT OF EDUCATION

NAME____________________

DATE STARTED____________

DATE COMPLETED________

BY
R. E. LILLO
N. S. SOFFIOTTO

STATE ELECTRICITY/ELECTRONICS CURRICULUM GUIDE
INSTRUCTOR'S GUIDE TO ACCOMPANY LEVEL II UNIT #6

Title of Unit: Nature of Electricity

Time Allocation: 1 week

Unit Goal:

To achieve student competence in analyzing the characteristics of the tiny building block of all electrical or electronic circuitry - the atom, and to develop a familiarity with the basic units and terms that will be encountered over and over again.

Unit Objectives:

The student will be able to:

1. differentiate and identify the basic parts of the atom, and the fundamental laws of charged bodies.
2. explain the definition for both voltage and current, and indicate the proper units of measurement for each quantity.
3. demonstrate the ability to connect a simple electrical circuit together, and to state the purpose of the individual components referred to as the supply, control, conductor, and load.

Evaluation:

The student will demonstrate his/her competence in terms of these measurable objectives based upon individual instructors acceptable performance criteria, which may utilize a combination of written, oral, and laboratory testing procedures.

Instructor References:

Basic Principles of Electricity. Vester Robinson, Reston Publishing Company, 1973. Chapter: 1.

Electronic Communication. Robert L. Shrader, McGraw-Hill Book Company, 1975. Chapter: 1.

Fundamentals of Electricity. Robert Seippel, American Technical Society, 1974. Chapters: 1 and 2.

Overview:

The unit should be initially introduced by indicating that the study of electrical theory and its applications requires a knowledge of the atom and its basic structure.

Upon this foundation the next topics can be presented in a more meaningful manner. For example, the law of static attraction and repulsion, and the concept of electrons in motion can now be digested easily by the student, if these topics succeed a discussion on the basic nature of matter.

The instructor should next present and impress students with the difference between potential difference and current flow, in order to encourage a thorough understanding of basic quantities and their proper units of measurement.

This unit concludes with an "in-depth" evaluation of the electrical make-up of a simple circuit. A variety of appropriate exercises and laboratory experiments and or projects should be coordinated with all unit topics when feasible.

Suggested Presentation Hints/Methodology:

Follow the instructional module unit outline as a basic skeleton for curriculum presentation, however, note the following:

1. When explaining the concept of electron movement or flow be sure to explain the electron action as a "chain reaction" effect. All too often students believe one electron travels through the circuit at a fantastic speed operating all devices it encounters.
2. During the discussion on current flow, refer to the reasons why the current carriers (electrons) always travel towards the positive side of the circuit. Substantiate this concept with the basic law of charged bodies, this kind of foundation will allow students an opportunity to truely understand basic current flow characteristics.
3. Introducing measurement units in electricity is sometimes hard to explain to students, so first find some common ground by asking the class for standard units of measurement for distance, speed, weight, and temperature. Once the idea of units of measurement has been established it is simple to ease into a discussion on electrical units of measurement.
4. The final topic which essentially explores the structure of a simple circuit is probably the most important topic in terms of technical information. Develop a couple of simple experiments to vividly illustrate how each basic requirement (part) of a circuit is utilized, and then explain the fundamental relationship that they enjoy with each other.

Supplemental Activities and Demonstrations:

1. Obtain a three foot acrylic tube with a diameter slightly larger than a ping-pong ball. Fill the tube (conductor) and perform a variety of demonstrations. Insert one ball in and observe the "chain reaction" which will culminate with one ball exiting the opposite end of the tube. Apply a force (voltage) by blowing into the tube and observe the internal flow. Finally, insert a color ball into one end of the tube and as succeeding balls pop out keep inserting them into the opposite end while watching the colored ball travel through the tube. Discuss electron flow in terms of this demonstration.
2. If possible obtain a wall chart of the periodic table of the elements and utilize it during the presentation on the basic structure of the atom. Check with other departments for a possible loan of this visual aid.

Instructional Module Contents:

1. Unit Outline (overhead)
2. Pre-Post Test (keyed)
3. Technical Glossary
4. Worksheet (vocabulary) - Crossword Puzzle
5. Quest Activities
6. Informational Handout (Structure of the Atom)
7. Unit Module Answer Keys

VI. Nature of Electricity

- A. Structure of the Atom
- B. The Electron
- C. Behavior of Charged Bodies
- D. Voltage/Potential Difference
- E. Current/Flow of Electrons
- F. Units of Measurement
- G. Simple Electric Circuit
    - 1. Supply
    - 2. Control
    - 3. Conductor
    - 4. Load

Test Number _____

LII-U6

UNIT EXAM

NATURE OF ELECTRICITY

IMPORTANT-

Indicate your responses on the answer sheet only. Fill in the box corresponding to the correct answer to each question - there is only one correct answer for each question.

1. The atomic number indicates the number of neutrons in the atom. (T-F)

2. A neutral atom has as many electrons as it has protons. (T-F)

3. Basically, the atomic weight of an atom is equal to the number of neutrons plus the number of protons. (T-F)

4. The proton has a negative charge and orbits around the nucleus. (T-F)

5. A conductor is a material which allows current to flow through it. (T-F)

6. The flow of current through a circuit is measured in volts. (T-F)

7. Motors, lamps, bells, and heaters are devices used as loads in electrical circuits. (T-F)

8. A supply provides the source of voltage and current for circuit operation. (T-F)

9. Voltage provides the "pressure" needed to force electrons through a circuit. (T-F)

10. Electrons always flow from negative to positive in an electrical circuit. (T-F)

11. Voltage is measured in the basic unit __________.

12. The ampere is the basic unit of measurement for __________.

13. To qualify as a complete electrical circuit, a supply, conductor, a load and a __________ are required.

14. Using the information given below, determine the number of neutrons present in the gold atom. __________ neutrons.

GOLD 197

$_{79}\mathrm{Au}$

15. Electricity travels through a wire, or circuit at about the speed of __________.
(A) sound, (B) wind, (C) water, (D) light.

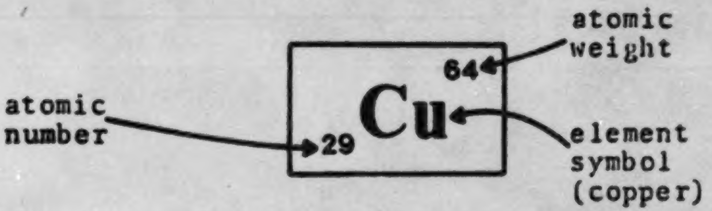
Name: ____________________

Date: ____________________

Period: ____________________

TECHNICAL GLOSSARY

AMPERE:	The basic unit of measurement for current. Abbrev. A
ATOM:	The smallest particle that an element can be divided into, and still have all the characteristics of that element. For example: the smallest possible bit of copper, that can be removed from a penny would be an atom of copper. Atoms contain three basic particles - protons, electrons, and neutrons.
ATOMIC NUMBER:	One of two numbers appearing by each element of the "periodic table." The atomic number is the smaller of the two numbers, and indicates the total number of protons in the nucleus of the particular atom. Example:



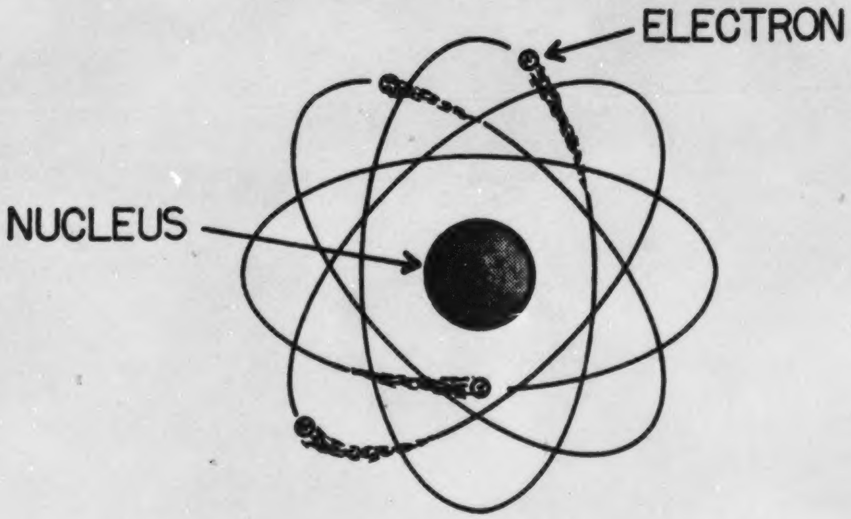
ATOMIC WEIGHT:	The second of two numbers appearing with each element on the "periodic table." The atomic weight indicates the total mass of the nucleus of the atom.
COMPLETE CIRCUIT:	An electrical circuit which contains at least a; supply, load, control, and conductor. All functional electrical circuits must contain these 4 basic parts.
CONDUCTOR:	A material which freely allows current to flow through it. Example: copper, aluminum, and silver are conductors.
CONTROL:	The part of a complete circuit which turns on, turns off, or routes (directs) current through a circuit. A switch is an example of a control.
CURRENT:	The orderly flow of electrons through an electrical circuit. Abbrev. I.
ELECTRON:	The negatively charged particle in an atom. The electrons are located in the "shells," and orbit around the nucleus.
ELECTRON SHELL:	The location of the electrons within the atom. Each layer of electrons constitutes a shell, and each shell has a maximum population.
LOAD:	The device which a circuit is designed to operate. Common circuit loads are motors, lamps, speakers, heating elements, etc.

Name: ____________________

Date: ____________________

Period: ____________________

NEUTRON:	An atomic particle located in the nucleus of the atom and is neutral (neither positive nor negative) in charge.
NUCLEUS:	The center mass of an atom, which contains the protons and neutrons. The nucleus forms the central "core" of the atom, and also contains the majority of the atom's mass.
PROTON:	An atomic particle, located in the nucleus of the atom, and having a positive charge.
SUPPLY:	The device which provides, or supplies, the necessary voltage and current for circuit operation. Some typical supply devices are batteries, generators, and solar cells. The supply is often refered to as the source.
VALENCE SHELL:	The outer most electron shell of the atom, also referred to as the "hook". The valence shell is the most chemically and electrically active of the electron shells. It is the valence electrons which basically determine a materials electrical characteristics.
VOLT:	The basic unit of measurement for voltage. Abbrev. V
VOLTAGE:	The electrical force or pressure which causes electrons to move through a circuit. Other terms for voltage are electromotive force and potential difference. Abbrev. E



SCORE:

GRADE:

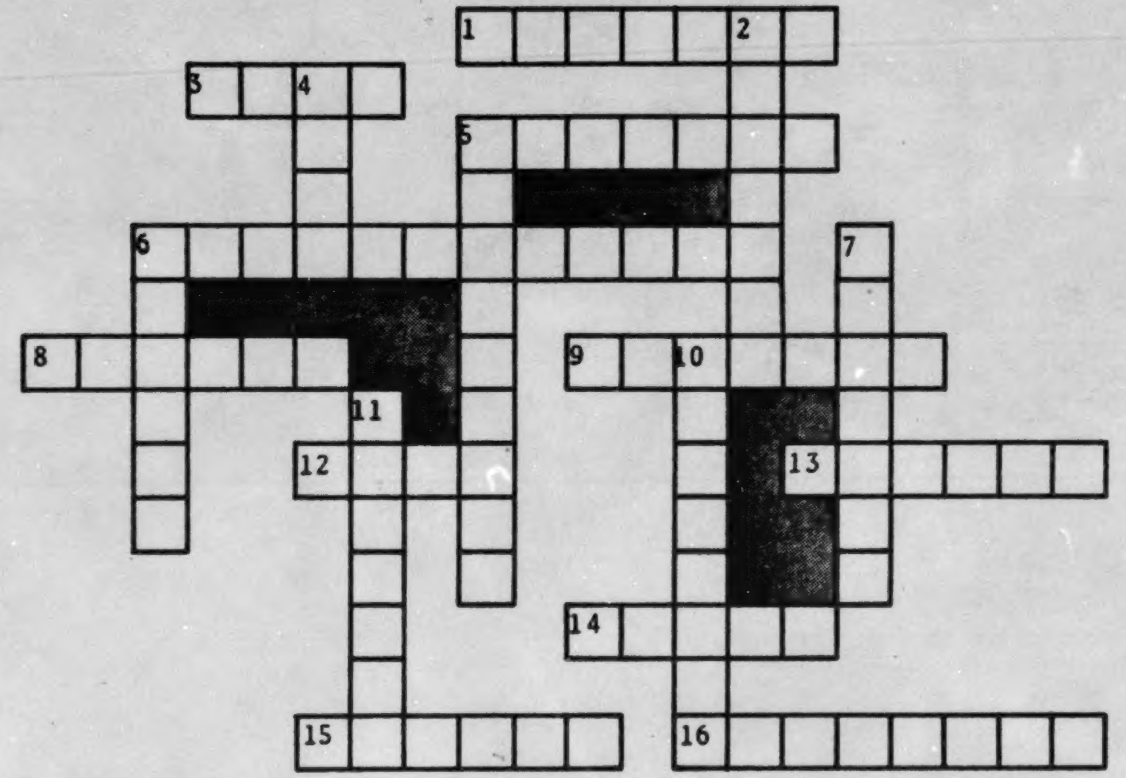
Name: ____________________

Date: ____________________

Period: ____________________

WORKSHEET

VOCABULARY - CROSSWORD PUZZLE



ACROSS

1. The outer most electron shell.
3. The device a circuit is designed to operate.
5. The orderly flow of electrons through a circuit.
6. Identifies the number of protons in an atom.
8. The part of a circuit which provides the voltage and current for operation.
9. The center of the atom.
12. The basic unit for voltage.
13. The positive particle in the nucleus of the atom.
14. The location of electrons in an atom.
15. The atomic ____________ indicates the mass of an atom.
16. The negative particle in an atom.

DOWN

2. The part of a complete circuit which "directs" current flow.
4. The smallest particle into which an element can be divided.
5. A material which allows, or supports current flow.
6. The basic unit for current flow.
7. A neutral partical in the center of the atom.
10. An electrical circuit which contains a supply, load, control, and conductor.
11. Electromotive force.

SCORE:

GRADE:

Name: ____________________

Date: ____________________

Period: ____________________

WORKSHEET

QUEST ACTIVITY

"UNIT 6"

1. Electrons orbit around the nucleus of the atom in paths called __________.	1. ☐
2. The nucleus of the atom contains both A) __________ and B) __________.	2A. ☐ 2B. ☐
3. The atomic __________ indicates the number of protons in the atom.	3. ☐
4. A neutral atom will contain the same number of A) __________ and B) __________.	4A. ☐ 4B. ☐
5. The outer most electron shell of an atom is called the __________ shell.	5. ☐
6. Electromotive force is commonly called A) __________ and is measured in the basic unit of the B) __________.	6A. ☐ 6B. ☐
7. The orderly flow of electrons through a circuit is called A) __________ and is measured in the basic unit of the B) __________.	7A. ☐ 7B. ☐
8. The smallest particle that an element can be divided into, and still retain all its characteristics is called an __________.	8. ☐
9. Unlike electrical charges will A) __________ while like electrical charges B) __________.	9A. ☐ 9B. ☐
10. A positively charged particle will attract both a A) __________ charged or B) __________ particle.	10A. ☐ 10B. ☐

11. List the three basic atomic particles, and their electrical charges.

PARTICLE		CHARGE
☐	- - -	☐
☐	- - -	☐
☐	- - -	☐

Name: ____________________

Date: ____________________

Period: ____________________

12. Draw a sketch of the boron atom.

Boron 11
$_{5}$**B**

13. Draw a sketch of the copper atom.

Copper 64
$_{29}$**Cu**

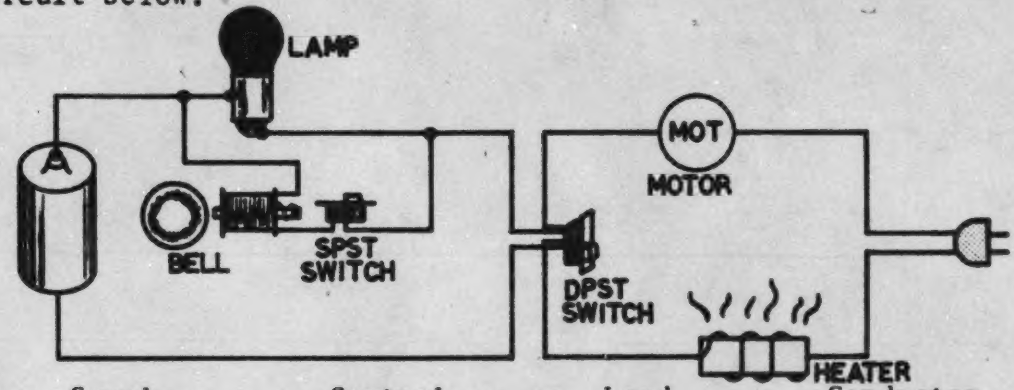
14. Draw a diagram of a simple complete electrical circuit. *Label the four characteristic parts of the circuit.*

Name: ____________________

Date: ____________________

Period: ____________________

15. Identify the supply, control, load, and conductor elements in the circuit below.


LAMP
A
MOT
MOTOR
BELL
SPST SWITCH
DPST SWITCH
HEATER

Supply Devices	Control Devices	Load Devices	Conductor Element

Name: ______________

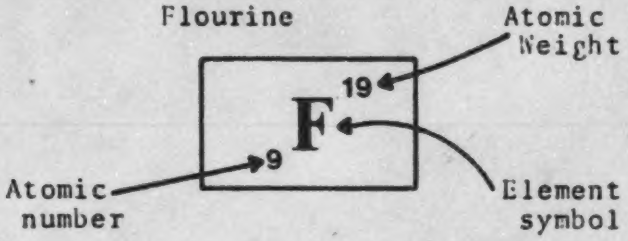
Date: ______________

Period: ______________

INFORMATIONAL HANDOUT

STRUCTURE OF THE ATOM

INFORMATION FOUND ON PERIODIC TABLE:



DRAWING AN ATOM:

To draw an atom you must know the number of protons, electrons, and neutrons present in the atom. The atomic number provides part of this information - it indicates the number of protons found in the nucleus of the atom. In their pure form, an atom will have an equal number of protons and electrons, so the atomic number actually indicates the total number of protons or electrons. To find the number of neutrons in the atom, simply subtract the atomic number from the atomic weight.

Using the information given about the flourine atom, you should then be able to list the number of protons, electrons, and neutrons found in that atom.

Protons - 9

Electrons- 9

Neutrons - 10

Once the above information is determined a simple sketch of the atom can be made as follows:

1) Draw the protons and neutrons in the nucleus of the atom, which is located in the center of the diagram.

2) The electrons orbit around the nucleus, and are located in the electron shells. Each shell has a maximum population, as follows:

1st shell	2nd shell	3rd shell	4th shell
2 electrons	8 electrons	18 electrons	32 electrons

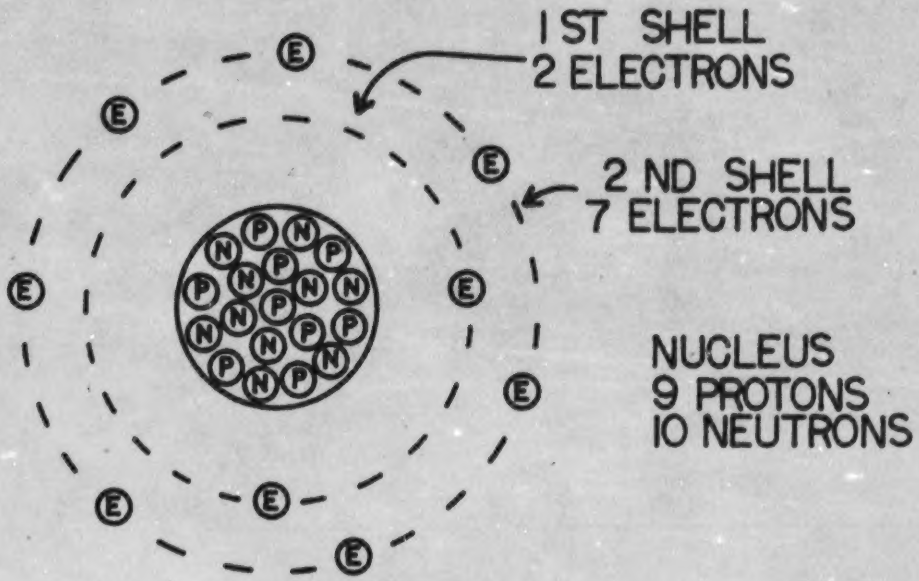
The electrons must then be placed in the shells, beginning with shell #1, filling each shell before moving to the next.

Name: ____________________

Date: ____________________

Period: ____________________

Flourine Atom


1 ST SHELL
2 ELECTRONS
2 ND SHELL
7 ELECTRONS
NUCLEUS
9 PROTONS
10 NEUTRONS

Now that you know the system, use your new knowledge to draw a sketch of the lithium atom.

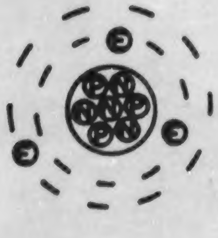
$_{3}\text{Li}^{7}$

Protons -

Electrons-

Neutrons -

Compare your answers with the sketch below.



SCORE:.
GRADE:

Name: ______________________

Date: ______________________

Period: ______________________

ANSWER SHEET

EXAM LII U6

	T A	F B	C	D		T A	F B	C	D		T A	F B	C	D		T A	F B	C	D
1.		■			26.					51.					76.				
2.	■				27.					52.					77.				
3.	■				28.					53.					78.				
4.		■			29.					54.					79.				
5.	■				30.					55.					80.				
6.		■			31.					56.					81.				
7.	■				32.					57.					82.				
8.	■				33.					58.					83.				
9.	■				34.					59.					84.				
10.	■				35.					60.					85.				
11.	volt				36.					61.					86.				
12.	current				37.					62.					87.				
13.	control				38.					63.					88.				
14.	118				39.					64.					89.				
15.				■	40.					65.					90.				
16.					41.					66.					91.				
17.					42.					67.					92.				
18.					43.					68.					93.				
19.					44.					69.					94.				
20.					45.					70.					95.				
21.					46.					71.					96.				
22.					47.					72.					97.				
23.					48.					73.					98.				
24.					49.					74.					99.				
25.					50.					75.					100.				

*Show work for problems on back of answer sheet.

ANSWER KEY
UNIT 6

A. CROSSWORD PUZZLE

ACROSS
1. valence
3. load
5. current
6. atomic number
8. supply
9. nucleus
12. volt
13. proton
14. shell
15. weight
16. electron

DOWN
2. control
4. atom
5. conductor
6. ampere
7. neutron
10. complete
11. voltage

B. QUEST ACTIVITY

1. shells
2A. protons
2B. neutrons
3. number
4A. electrons
4B. protons
5. valence
6A. voltage
6B. volt
7A. current
7B. ampere
8. atom
9A. attract
9B. repel
10A. negatively
10B. neutral
11. electron -
proton +
neutron o
12.

(subjective answer)

13.

(subjective answer)

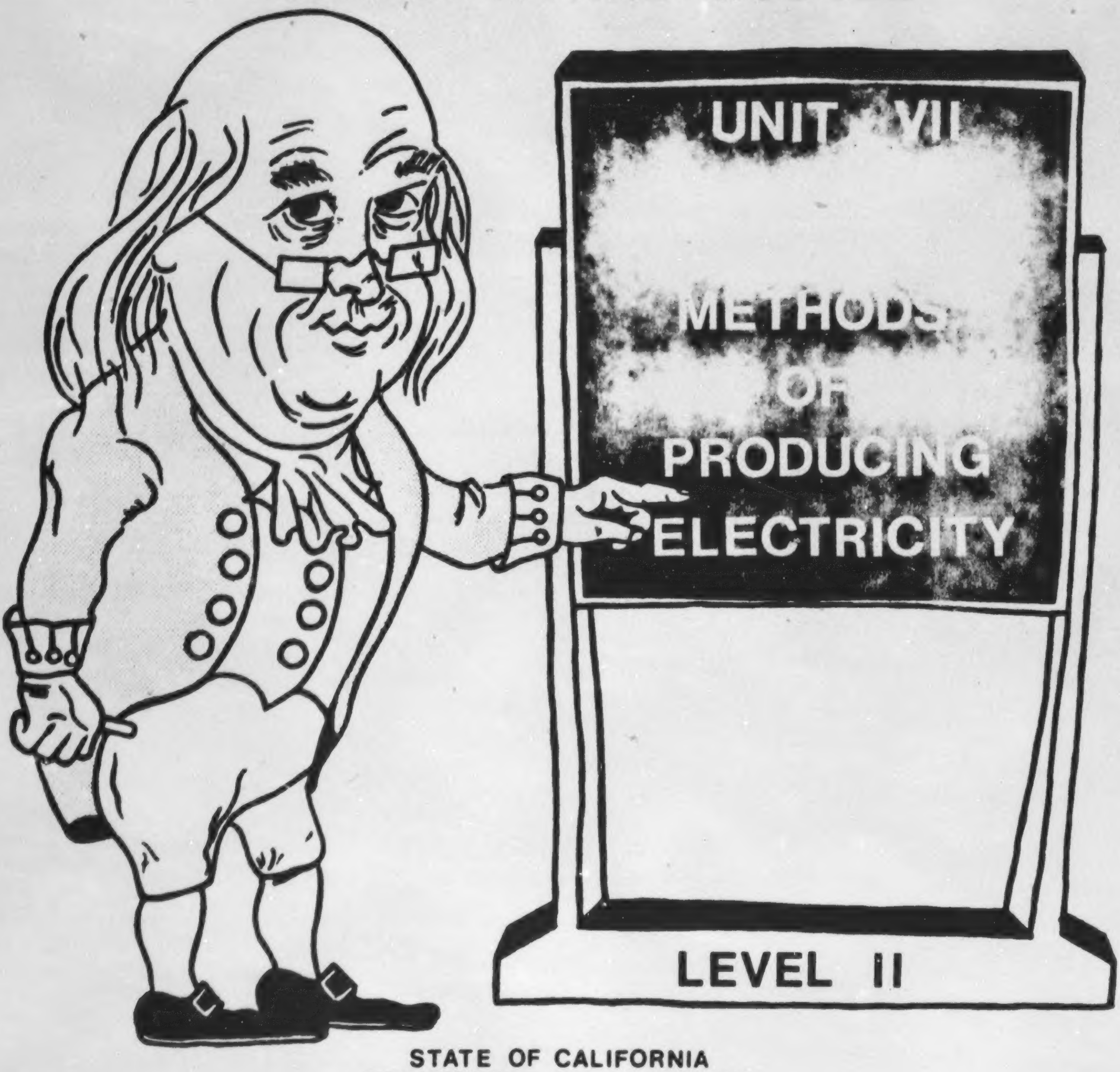
14.

(subjective answer)

15. Supply devices
cell
AC
Control devices
DPST switch
SPST switch
Load devices
lamp
bell
heater
motor
Conductor element
wire

ELECTRICITY / ELECTRONICS

CURRICULUM GUIDE
INSTRUCTIONAL MODULE


UNIT VII
METHODS OF PRODUCING ELECTRICITY
LEVEL II

STATE OF CALIFORNIA
DEPARTMENT OF EDUCATION

NAME____________________
DATE STARTED____________
DATE COMPLETED__________

BY
R. E. LILLO
N. S. SOFFIOTTO

STATE ELECTRICITY/ELECTRONICS CURRICULUM GUIDE
INSTRUCTOR'S GUIDE TO ACCOMPANY LEVEL II UNIT #7

Title of Unit: Methods of Producing Electricity

Time Allocation: 1 week

Unit Goal:

To disclose those competencies which will introduce the student to a variety of sources and/or methods of producing electricity, and to expose students to other related energy considerations such as cost, availability, conservation, and power potential.

Unit Objectives:

The student will be able to:

1. identify six methods of producing electricity.
2. illustrate by example how each of the sources discussed produces electricity.
3. explain the necessity for energy conservation, methods of conserving energy in the home, and alternative energy source availability.

Evaluation:

The student will demonstrate his/her competence in terms of these measurable objectives based upon individual instructors acceptable performance criteria, which may utilize a combination of written, oral, and laboratory testing procedure.

Instructor References:

Basic Electronics Systems Technology Unit 1. Dugger, Patrick, Suess, and Ziegler, Bruce, 1973. Lessons: 2-6.

Electricity and Electronics. Walter B. Ford and William B. Steinberg, American Technical Society, 1974. Units: 6-9.

Electricity One-Seven. Harry Mileaf, Hayden Book Company, Inc., 1976. Chapter: Electricity 1.

Overview:

Unit 7 focuses on the fact that electricity has become an essential part of our life, therefore it is important to be aware of the sources for creating electrical energy.

The instructor should first examine the sources that are available, then identify those which are small-scale sources and those that are classified as large-scale sources in terms of power produced.

This unit introduces the six basic sources of electricity along with some of the details of application. The actual concept of "how" these sources generate electricity will be considered at a later time.

The unit topic also emphasizes other vital considerations associated with the consumption of energy.

A variety of appropriate exercises and laboratory experiments and/or projects should be coordinated with all unit topics when feasible.

Suggested Presentation Hints/Methodology:

Follow the instructional module unit outline as a basic skeleton for curriculum presentation, however, note the following:

1. Try not to leave the impression that the sources presented in this unit are the only sources; they are just the most common ones. Explain further that many other sources have potential, yet, are still in the experimental stage in terms of development.
2. Most of the methods of producing electricity can be explored in greater depth during laboratory activities in which the student physically examines and/or performs a variety of experimentation.
3. When discussing heat, light, or pressure methods of producing electricity, under small-scale production, it is important to emphasize that these methods are primarily utilized in control or sensing types of circuits.
4. Discuss with the class, alternatives to electrically powered entertainment. Ask the students to list non-electrical leisure activities they presently participate in and then have them describe their feelings in terms of this condition being a permanent part of their life style.
5. Introduce new career choices to your class which may exist in the future in such special energy areas as solar, geothermal, wind power, and nuclear fusion.

Supplemental Activities and Demonstrations:

1. Producing electricity through heat action can be demonstrated by using a pair of wires (iron and nichrome) and a large galvanometer. Twist the loose ends of the wires together and heat the junction with a match.
2. Producing electricity through pressure action can be demonstrated with a record player pickup. Apply pressure to the needle and then measure the voltage across the cartridge.
3. Producing electricity through light action can be demonstrated with a measurement of the output of a solar cell. The output will increase as the light striking its face increases.

Instructional Module Contents:

1. Unit Outline (overhead)
2. Pre-Post Test (keyed)
3. Technical Glossary
4. Worksheet (vocabulary) - Scrambled Word Puzzle
5. Quest Activities
6. Informational Handout (Six Methods Used To Produce Electricity)
7. Unit Module Answer Keys

VII. Methods of Producing Electricity

A. Six Methods of Producing Electricity
   1. Friction
   2. Chemical
   3. Heat
   4. Light
   5. Pressure
   6. Magnetic

B. Using Energy
   1. Home consumption
   2. Conserving energy
   3. Alternative sources

Test Number ____

LII-U7

UNIT EXAM

METHODS OF PRODUCING ELECTRICITY

IMPORTANT-

Indicate your responses on the answer sheet only. Fill in the box corresponding to the correct answer to each question - there is only one correct answer for each question.

1. Static electricity is generated by heat. (T-F)

2. When a charged rod is brought close to a neutral material, attraction occurs. (T-F)

3. The two types of static charges are positive and neutral. (T-F)

4. A primary cell can usually be recharged. (T-F)

5. The amount of electrical energy used in the home is measured in kilowatt-hours. (T-F)

6. A battery changes chemical reactions into electrical energy. (T-F)

7. Light shining on a thermocouple will produce a small amount of electricity. (T-F)

8. Moving a magnet into a coil of wire will produce electricity. (T-F)

9. A solar cell is an example of a piezoelectric device. (T-F)

10. Many devices use less energy when left on and operating, than if they were to be turned on and off as needed. (T-F)

11. A charged rubber rod will attract:
(A) a charged glass rod, (B) a positively charged material, (C) a neutral material, (D) all of the above.

12. The liquid in a wet cell is called the:
(A) acid juice, (B) electrolyte, (C) chemical composition, (D) electrode.

13. Piezoelectricity is electricity produced by:
(A) heat, (B) chemical reactions, (C) pressure, (D) magnetism.

14. A generator requires a coil of wire, motion, and __________ in order to produce electricity.
(A) light, (B) heat, (C) friction, (D) magnetism.

15. Which of the following is an example of a photoelectric device?
(A) solar cell, (B) thermocouple, (C) battery, (D) rochelle salt crystal.

Name: ____________

Date: ____________

Period: ____________

TECHNICAL GLOSSARY

ACID:	A strong chemical substance with corrosive properties. Vinegar, is an example of a weak acid, other common acids are citric acid and sulfuric acid.
ALTERNATIVE:	Refers to another choice, or possible selection. Alternative energy sources could include such things as wind power, solar energy, tidal power, and nuclear power.
BATTERY:	Two or more voltaic cells connected together in either series or parallel. A battery is an important source of DC electrical energy because it is self-contained, and portable.
CELL:	A single voltaic unit, which is formed by combining two dissimilar metals and an acid solution.
CHEMICAL ELECTRICITY:	A source of DC electricity, which is produced by chemical reactions. A cell and a battery are examples of chemical electrical devices.
COIL:	A number of turns of insulated wire, usually wrapped in circular form. A coil of wire is a necessary part or element in a generator.
CONSERVATION:	The process of saving or limiting the use of a resource, such as electrical energy.
CONSUMPTION:	The act of using up, or consuming a resource, such as electrical energy.
DISSIMILAR:	Referring to materials that have different characteristics. Two dissimilar metals for example would be copper and zinc.
ENERGY:	A force which is capable of doing "work." Common sources of energy would include electricity, steam, falling water, nuclear reactions, combustion (fire), etc.
GENERATOR:	A device used to produce electricity, either AC, or DC, by moving a coil of wire through a magnetic field; or by keeping the coil stationary, and moving the magnetic field.
PHOTOELECTRICITY:	A source of DC electricity, which is released, or produced by light energy. Photoelectrical devices are of three types - photovoltaic, photoconductive, and photoemissive. Only the photovoltaic devices produce electricity directly from light.

Name: ____________________

Date: ____________________

Period: ____________________

PIEZOELECTRICITY:	A source of electricity which is produced when a varying pressure is applied to a certain crystal material, such as quartz, Rochelle salts, or barium titanate.
PRIMARY CELL:	A type of voltaic cell, which will produce electricity as soon as the chemicals are combined, and generally cannot be recharged.
SECONDARY CELL:	A cell which requires charging before it will produce electricity, and has the advantage of being continually rechargeable.
STATIC ELECTRICITY:	A collection of electrical charges (both positive, and negative) at rest on the surface of an object. Static charges are generated or produced by friction.
THERMOCOUPLE:	A device consisting of two dissimilar metals, joined at a junction. When the junction is heated, a small amount of DC electricity is produced.

~~WASTED ENERGY~~
CONSERVE

SCORE:

GRADE:

Name: ____________________

Date: ____________________

Period: ____________________

WORKSHEET

VOCABULARY - SCRAMBLED WORD PUZZLE

Unscramble the letters below to uncover the electronic terms.

EXAMPLE:

A. EECCIITTRYL	A. ELECTRICITY
1. LECL	1.
2. CADI	2.
3. TICTAS	3.
4. NEERYG	4.
5. TABEYRT	5.
6. LCCHAEIM	6.
7. TEENGORRA	7.
8. SMILSIRDAI	8.
9. LEARNATEVIT	9.
10. CATNOSENORIV	10.
11. RDAOECSYN	11.
12. TPNMSCNOOIU	12.
13. EEERZPLCCIIIOYTT	13.
14. MOTORHEELCUP	14.
15. TELETOPHOTRYCCII	15.

SCORE:

GRADE:

Name: ____________________

Date: ____________________

Period: ____________________

WORKSHEET

QUEST ACTIVITY

"UNIT 7"

Choose ten items, that you use most frequently, from the list of common household appliances below. Then, locate and record the wattage rating for those items. Normally these ratings will be found stamped into the body of the appliance, or on a metal plate affixed to the device. Record your findings in the space provided on the chart.

COMMON HOUSEHOLD APPLIANCES

Wattage rating	Device	Wattage rating	Device
	Air Conditioner (room)		Hot Curlers
	Black and White TV		Hot Plate
	Blender		Iron
	Blow Dryer		Lamps and Lighting
	Clock		Mixer
	Clock Radio		Oven, Microwave
	Coffee Maker		Pop Corn Popper
	Color TV		Projector
	Curling Iron		Radio
	Drill (portable)		Stereo/receiver
	Electric Blanket		Sewing Machine
	Electric Can Opener		Shaver
	Electric Typewriter		Sun Lamp
	Electronic TV Game		Tape Recorder
	Fan		Toaster
	Food Processor		Vacuum Cleaner
	Fry Pan		Waffle Iron

Answer the following questions after you have completed your research.

1. Which of your devices has the highest wattage rating? ____________________
2. Which device has the lowest wattage rating? ____________________
3. Which devices do you use most often? ____________________ ____________________
4. Based on your list which devices have higher wattage ratings, those without heating elements or those with heating elements? ____________________
5. On a weekly basis, which device consumes the most energy? (Consider wattage rating and time of use). ____________________
6. What pratical things could you do to reduce your consumption of electrical energy?

Name: ____________________

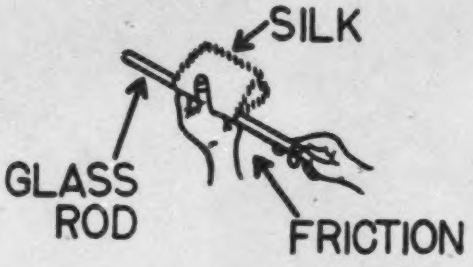
Date: ____________________

Period: ____________________

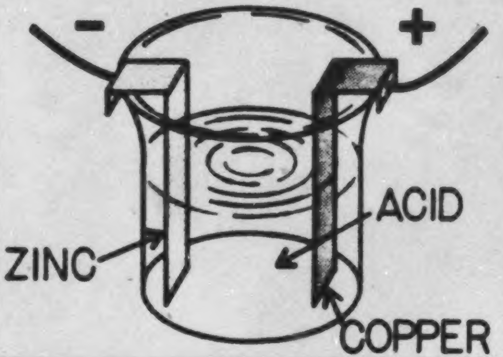
INFORMATIONAL HANDOUT

SIX METHODS USED TO PRODUCE ELECTRICITY

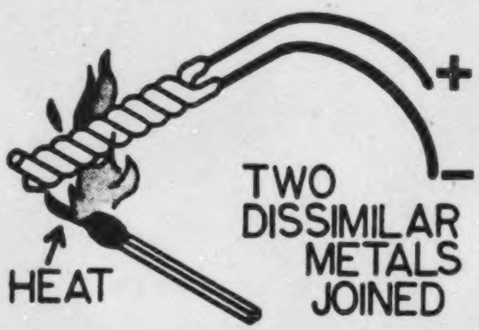
-Electricity from friction-
(static electricity)


SILK
GLASS ROD
FRICTION

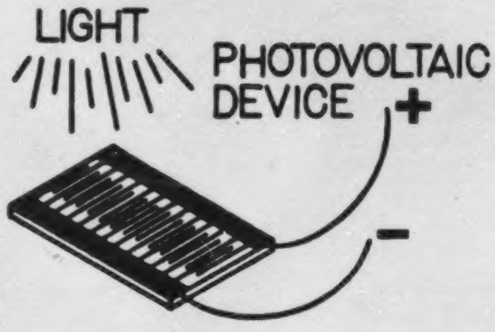
-Electricity from chemicals-
(chemical electricity)


-
+
ACID
ZINC
COPPER

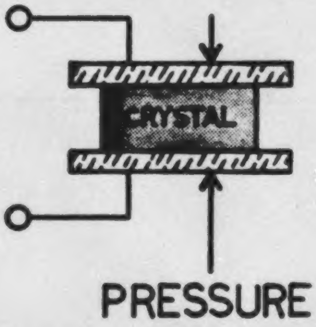
-Electricity from heat-
(thermoelectricity)


+
-
TWO DISSIMILAR METALS JOINED
HEAT

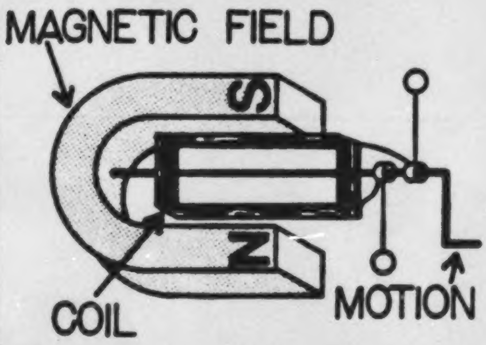
-Electricity from light-
(photoelectricity)


LIGHT
PHOTOVOLTAIC DEVICE
+
-

-Electricity from pressure-
(piezoelectricity)


CRYSTAL
PRESSURE

-Electricity from magnetism-
(magnetoelectricity)


MAGNETIC FIELD
S
N
COIL
MOTION

SCORE:
GRADE:

Name: ________________

Date: ________________

Period: ________________

ANSWER SHEET

EXAM LII U7

	T A	F B	C	D		T A	F B	C	D		T A	F B	C	D		T A	F B	C	D
1.		●			26.					51.					76.				
2.	●				27.					52.					77.				
3.		●			28.					53.					78.				
4.		●			29.					54.					79.				
5.	●				30.					55.					80.				
6.	●				31.					56.					81.				
7.		●			32.					57.					82.				
8.	●				33.					58.					83.				
9.		●			34.					59.					84.				
10.	●				35.					60.					85.				
11.				●	36.					61.					86.				
12.		●			37.					62.					87.				
13.			●		38.					63.					88.				
14.				●	39.					64.					89.				
15.	●				40.					65.					90.				
16.					41.					66.					91.				
17.					42.					67.					92.				
18.					43.					68.					93.				
19.					44.					69.					94.				
20.					45.					70.					95.				
21.					46.					71.					96.				
22.					47.					72.					97.				
23.					48.					73.					98.				
24.					49.					74.					99.				
25.					50.					75.					100.				

*Show work for problems on back of answer sheet.

ANSWER KEY
UNIT 7

A. SCRAMBLED WORD PUZZLE

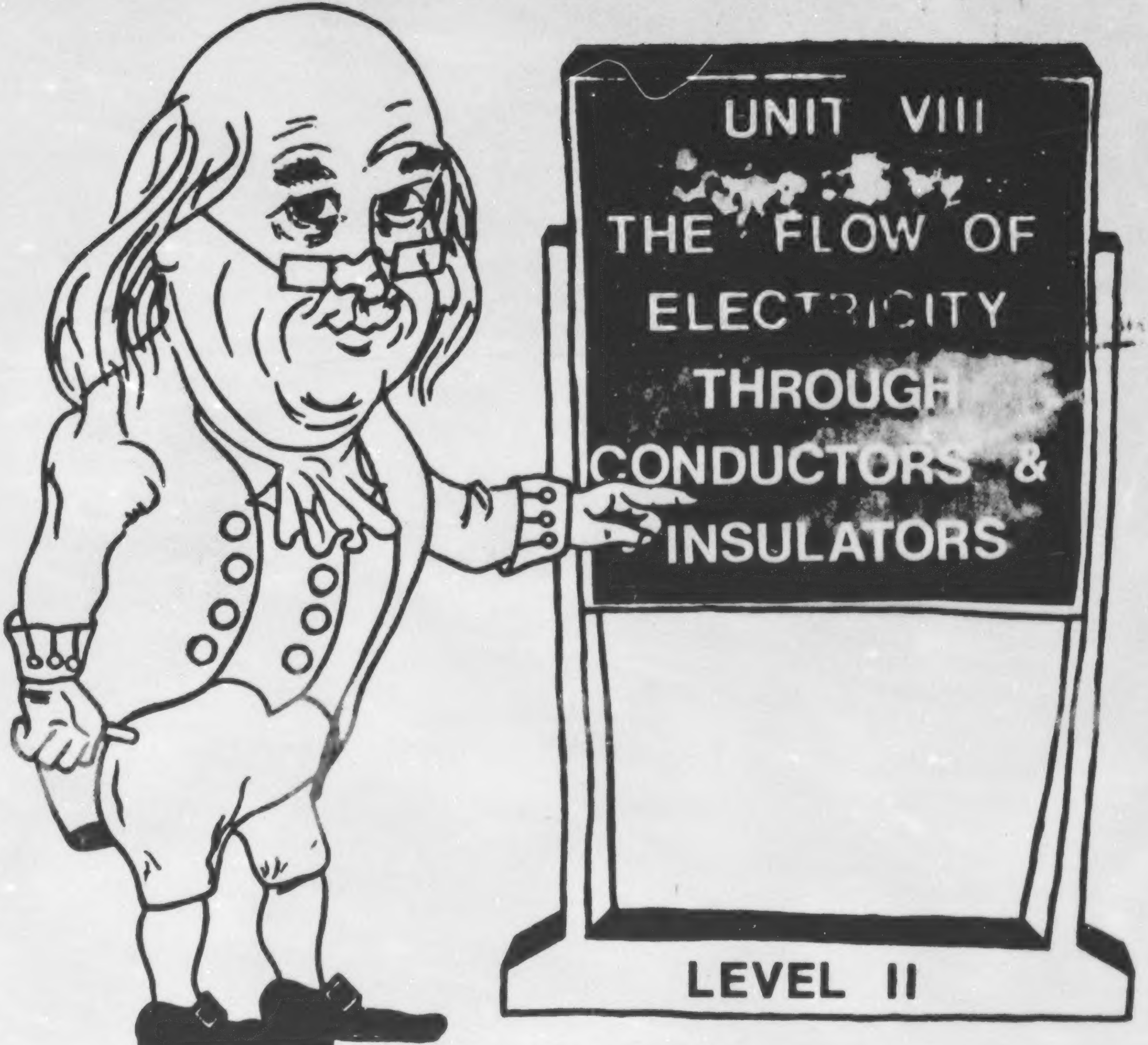
1. cell
2. acid
3. static
4. energy
5. battery
6. chemical
7. generator
8. dissimilar
9. alternative
10. conservation
11. secondary
12. consumption
13. piezoelectricity
14. thermocouple
15. photoelectricity

B. QUEST ACTIVITY

(subjective evaluation)

ELECTRICITY / ELECTRONICS

CURRICULUM GUIDE
INSTRUCTIONAL MODULE


UNIT VIII
THE FLOW OF ELECTRICITY THROUGH CONDUCTORS & INSULATORS
LEVEL II

STATE OF CALIFORNIA
DEPARTMENT OF EDUCATION

NAME____________________

DATE STARTED______________

DATE COMPLETED____________

BY
R. E. LILLO
N. S. SOFFIOTTO

Title of Unit: The Flow of Electricity Through Conductors and Insulators

Time Allocation: 1 week

Unit Goal:

To acquaint students with the general characteristics and electrical properties of specific materials, thus aiding student comprehension of the methods utilized for classifying materials as either conductors, insulators, or semiconductor devices.

Unit Objectives:

The student will be able to:

1. differentiate between the characteristics of conductors, insulators or semiconductors, and identify specific examples of materials that occupy each category.
2. describe the fundamental purpose and importance of conductors and insulators in relationship to an electrical or electronic circuit.
3. physically demonstrate an ability to properly strip both solid or stranded wire, and to verbally list the correct procedures to employ in order to obtain the aforementioned results.

Evaluation:

The student will demonstrate his/her competence in terms of these measurable objectives based upon individual instructors acceptable performance criteria, which may utilize a combination of written, oral, and laboratory testing procedures.

Instructor References:

Basic Electricity: Theory and Practice. Milton Kaufman and J.A. Wilson, McGraw-Hill Book Company, 1973. Chapter: 3.

Electricity and Basic Electronics. Stephen R. Matt, Goodheart-Willcox Company, Inc., 1977 Chapter: 3.

Introduction to Electricity. Kurt Harding Schick, McGraw-Hill Book Company, Ryerson Limited, 1975. Chapter: 6.

Overview:

This unit was created primarily as a means to investigate further the properties of practical types of conductors, insulators, and semiconductors.

Unit 4 also touched upon some similar basic electrical/mechanical skills to be learned, however, Unit 8 is more concerned with the specific electrical performance characteristics of these materials, along with expanding student competence in identifying, handling, and preparing wire.

The main lecture theme for all topics in this unit is that all materials may be electrically classified. The particular classification can be determined by the number of electrons which can be easily forced out of their specific orbits, and this is sometimes technically described as the number or availability of free electrons.

A variety of appropriate exercises, laboratory experiments, and/or projects should be coordinated with all unit topics when feasible.

Suggested Presentation Hints/Methodology:

Follow the instructional module unit outline as a basic skeleton however, note the following:

1. This unit provides an opportunity to explain some related factors to be considered when selecting or preparing conductors, so if time permits, discuss such considerations as types of wire, braids, multiple-wire cables, wire sizes, wire harnesses, lacing, and wire color code.
2. Hopefully, in this unit a variety of laboratory activities will be coordinated to assist students in developing or reviewing some basic mechanical and electrical skills. Simple exercises on wire identification, techniques of wire stripping, or methods of fabricating a wire harnesses can really help introduce students to many basic assembly procedures.
3. Wire stripping of stranded wire is taken for granted by many instructors, however, the correct technique is sometimes difficult for students to acquire. When teaching this skill make an effort to explain what happens electrically and mechanically when strands are broken during the stripping process.
4. Generally, teachers focus entirely on conductors in this kind of a unit, so remember do not overlook emphasizing insulators as a major subject topic. Two main discussion points can be that insulators are rated by the amount of voltage required to break down their insulating properties, and that insulators are selected according to the surroundings in which they will function.

Supplemental Activities and Demonstrations:

1. Create a visual display of an assortment of (wires) and their protective coverings (insulation). Materials can be mounted on a board and labeled to facilitate student examination and familiarity. Safety should be stressed as one important consideration for the utilization of insulations.
2. A simple operating lamp circuit with a means to cut in and out a test section for checking material conductivity, can assist the student in understanding the relationship of a conductor or insulator in an electrical circuit. Use a variety of material samples and observe the lamp for individual conductivity characteristics.
3. Bring in a container full of different types of insulators and have the students try to deduce the application of each one.

Instructional Module Contents:

1. Unit Outline (overhead)
2. Pre-Post Test (keyed)
3. Technical Glossary
4. Worksheet (vocabulary) - Know Your Definitions
5. Quest Activities
6. Informational Handout (Current Flow Through a Conductor)
7. Informational Handout (Wire: Purpose and Application)
8. Unit Module Answer Keys

VIII. The Flow of Electricity Through Conductors and Insulators

A. Classification
   1. Conductors

   2. Insulators

   3. Semiconductors

B. Current Flow Characteristics

Test Number _____

LII-U8

UNIT EXAM

THE FLOW OF ELECTRICITY THROUGH CONDUCTORS AND INSULATORS

IMPORTANT-
Indicate your responses on the answer sheet only. Fill in the box corresponding to the correct answer to each question - there is only one correct answer for each question.

1. A conductor provides a path through which electrons can freely flow. (T-F)

2. Plastic is a common conductor used on wires. (T-F)

3. Semiconductors contain five valence electrons. (T-F)

4. An insulator offers a difficult path for electron flow. (T-F)

5. Gold has the lowest resistance to current flow, and is known as the best conductor. (T-F)

6. The "effect" of an electric current moves at approximately the speed of light. (T-F)

7. Semiconductor materials have few uses in the field of electronics, and thus are not important substances. (T-F)

8. In order to cause electrons to flow through a wire, a voltage must first be applied. (T-F)

9. Stranded wire consists of one very flexible central conductor coated with an insulator, such as rubber. (T-F)

10. Electrons flow through a circuit from negative to positive. (T-F)

11. Copper and aluminum are the two most common conductor materials. (T-F

12. Insulators, such as glass, and ceramic are used when very high voltage is present. (T-F)

13. The best conductor for general electronic work is:
(A) copper, (B) aluminum, (C) silver, (D) tin.

14. Good insulators:
(A) have 8 electrons in their valence shell, (B) are compounds, (C) do not conduct electricity, (D) all of the above.

15. A semiconductor acts:
(A) as an insulator at high temperature, (B) as either an insulator or conductor, (C) as a conductor when it contains no impurities, (D) all of the above.

Name: ____________________

Date: ____________________

Period: ____________________

TECHNICAL GLOSSARY

CHAIN REACTION:	A series of events which occur in rapid order, due to some input or "starting" action. The toppling of a line of dominoes, or the flow of electrons through a wire are common examples of chain reactions.
CHEMICAL STABILITY:	An indiction of an atom's tendency to mix or react with other atoms. Generally, an atom with a full valence shell (8 outer electrons) will be very stable and thus not react chemically or electrically. An atom with only one valence electron, on the other hand is very unstable, and thus very chemically or electrically active.
CONDUCTOR:	A material through which an electrical current will easily flow. Conductors contain many free electrons which contribute to current flow. The best conductors contain only one valence electron and are metals.
DIELECTRIC:	A term used to describe an insulator. Thus, a dielectric material is also an insulating material.
ELECTRICAL IMPULSE:	The chain reaction caused when an electron is forced into a circuit, simultaneously causing another electron to leave the circuit. This electrical impulse, or chain reaction, continues throughout the circuit at the speed of light, as long as pressure is applied.
FREE ELECTRON:	Electrons which are removed from the valence shell of their atom, usually by electrical pressure, and are free to move through a wire or circuit. Free electrons moving in the same direction through a conductor produce an electric current.
INSULATOR:	A material which does not allow current flow. Insulators contain few free electrons and therefore do not provide an easy path for current flow. The best insulators contain eight valence electrons and are compounds such as plastic, glass, etc.
SEMICONDUCTORS:	A material that can act as either an insulator or conductor depending upon its temperature or chemical purity. Semiconductors contain four valence electrons and the most common examples are silicon and germanium.
SPEED OF LIGHT:	The speed at which light travels through the atmosphere. This speed has been established as 300,000,000 meters per second. Recall, an electrical impulse will travel through a conductor at the speed of light.
STRIPPING:	The process of removing the insulating material (plastic, cloth, enamel) from a wire or conductor.

SCORE:

GRADE:

Name: ____________________

Date: ____________________

Period: ____________________

WORKSHEET

VOCABULARY - KNOW YOUR DEFINITIONS

Develop a short definition, using your own words, for the following terms.

1. CONDUCTOR:

2. INSULATOR:

3. SEMICONDUCTOR:

4. FREE ELECTRON:

For the following vocabulary terms, include a sketch to enhance and clarify your "word" definition.

5. CHAIN REACTION:

6. ELECTRICAL IMPULSE:

SCORE:

GRADE:

Name:

Date:

Period:

WORKSHEET

QUEST ACTIVITY

"UNIT 8"

Utilizing a simple experimental technique (continuity tester, ohmmeter, simple series lamp circuit) or a research procedure (test book, and/or chemical handbook) classify the following materials as either conductors, insulators, or semiconductors. Write the results of your research activity in the box provided.

1. copper
2. plastic
3. cloth
4. steel
5. enamel
6. gold
7. silicon
8. glass
9. ceramic
10. silver
11. germanium
12. aluminum
13. mica
14. paper
15. carbon
16. wood
17. air
18. lead
19. paraffin wax
20. tin

Name: __________

Date: __________

Period: __________

21. The purpose of a conductor is:

22. The purpose of an insulator is:

23. List the three "best" conductors for electrical current flow.

23A.

23B.

23C.

24. The wire most commonly used for electrical conductors is made of soft, __________.

24.

25. Conductors contain many __________ electrons.

25.

26. The most common semiconductor materials are silicon and __________.

26.

27. Wire strippers are designed to remove the __________ from wires.

27.

28. List one desirable feature of solid wire.

29. Name one advantage stranded wire has over solid wire.

30. When a power cord uses a heavy gauge wire with thick plastic insulation or asbestos cloth insulation, what does it indicate about the load device?

Name: ____________

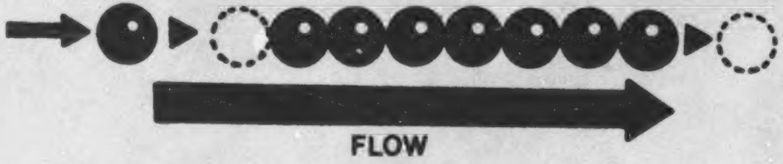
Date: ____________

Period: ____________

INFORMATIONAL HANDOUT

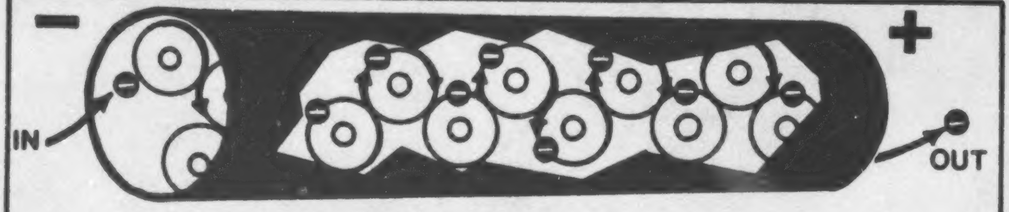
CURRENT FLOW THROUGH A CONDUCTOR

Electrical current flow is caused by an orderly flow of electrons through a circuit or conductor. You will find, that each time an electron enters a wire or conductor, another electron will be forced out of that conductor. This action is similar to the flow of energy through a long row of billard balls as shown below:



When the first ball is struck, the force is transferred from ball to ball until the last ball is forced from the row.

In a conductor, the valence electrons of the copper atoms, in effect become the billard balls. As the source or voltage forces an electron into the wire, that electron will enter a near by valence shell, forcing out the "resident" electron. This now free electron will in turn enter another near-by valence shell, forcing out its "resident" electron. This procedure continues until an electron exits the end of the wire. Although this procedure seems complex, it occurs at a very rapid speed 300,000,000 meters per second, or the speed of light.



The electrical phenomenon pictured above is known as an electrical impulse.

It may seem peculiar, but an individual electron moves rather slowly through a wire - approximately 10.92 millimeters per second (4.28 inches per second) - but, the total effect of an electrical current travels at the speed of light, which is.........

186,000 miles/sec.

Name: ____________________

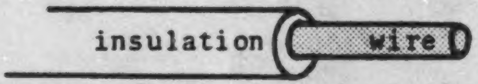
Date: ____________________

Period: ____________________

INFORMATIONAL HANDOUT

WIRE: PURPOSE AND APPLICATION

PURPOSE -



Wire is an essential part of all electrical circuits and you should review below some of the important factors to be considered when selecting or using wire.

A conductor (wire) provides the path or highway for the movement of electrons, and many times wire is covered with insulation to keep the current safely within the wire.

CONDUCTOR + INSULATOR = WIRE
CONDUCTOR - INSULATOR = BARE WIRE

Types of Wire -

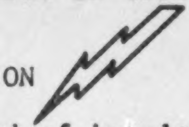
Solid wire is usually made from one thick copper thread. It is easy to handle and to solder, yet, when a lot of physical movement is necessary this kind of wire should not be used. You can purchase this wire in a variety of outside colors and sizes. Components like resistors, capacitors, inductors, and transformers have solid wires (leads) extending from the body of the device so that the component may be connected securely to the circuit.

USAGE EXAMPLE: Solid wire is used to complete electrical circuits in the walls of homes, schools and industries.

Stranded wire is made from a bunch or group of copper threads that have been twisted together to appear like one wire. When flexibility is important this is the type of wire to use. Remember that you must really be careful when stripping this kind of wire or some of the strands will be destroyed causing the wire to be both mechanically weak and not able to handle all of the current flow. Stranded wire is generally tinned with solder before being connected to a circuit point.

USAGE EXAMPLE: Stranded wire is used in cables, appliances, and extension cords.

WIRE INSULATION - PROTECTION

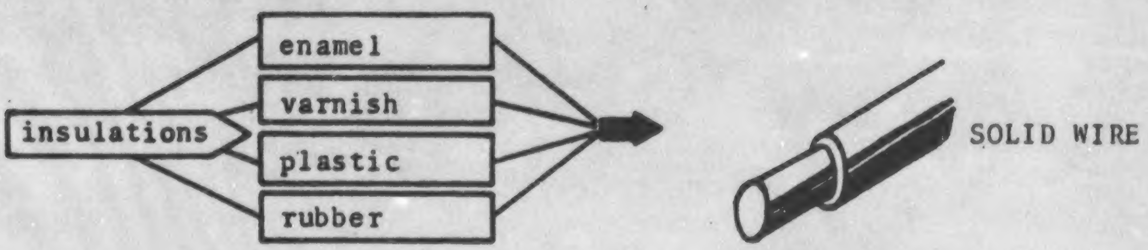


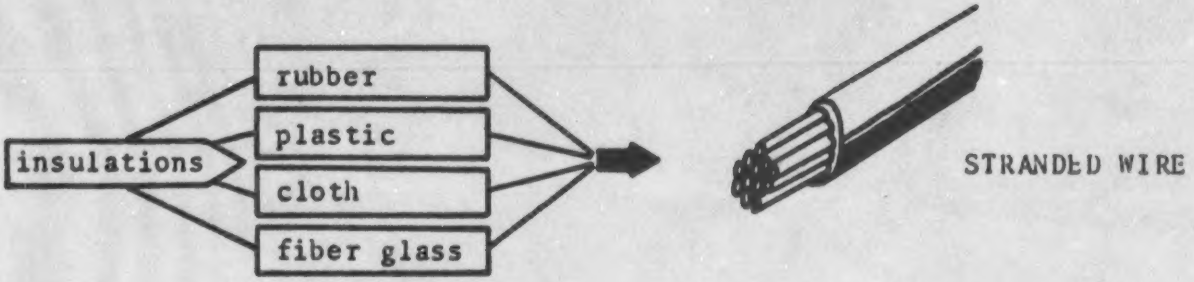
Most wires are covered by some kind of insulating material to prevent short circuits and dangerous accidents! Look at the various types of coverings associated with each kind of wire on the following page.

Name: ____________________

Date: ____________________

Period: ____________________


insulations
enamel
varnish
plastic
rubber
SOLID WIRE

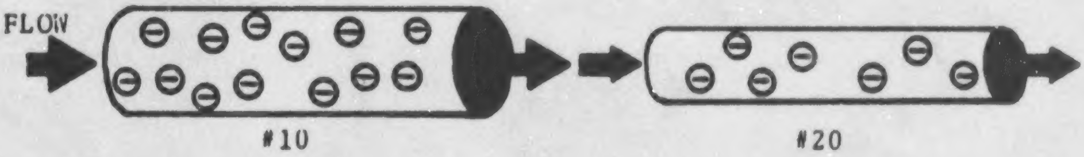

insulations
rubber
plastic
cloth
fiber glass
STRANDED WIRE

WIRE SIZES -

The American Wire Gauge (AWG) number is a system of describing by number, the size or electrical capacity of the wire. The larger the wire number, the smaller the diameter of the wire. Of course, it is important to select the proper size of wire for the job at hand.

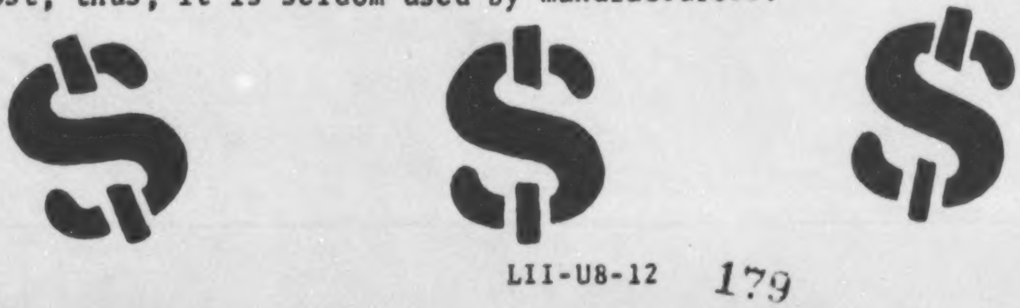
NOTE: A wire gauge is a device that can be used to determine the size of wire.

SIZE EXAMPLE: A #20 wire can carry less current than a #10 wire because the #20 is physically smaller in size, hence less current can travel through this wire.



WIRE IN GENERAL

Most wire is now made from copper because it is such a good conductor of electricity and can be purchased at a fair price. Silver is rated as a better conductor, however, it is far more expensive which means increased cost, thus, it is seldom used by manufacturers.



SCORE:

GRADE:

Name: ____________________

Date: ____________________

Period: ____________________

ANSWER SHEET

EXAM LII U8

	T A	F B	C	D		T A	F B	C	D		T A	F B	C	D		T A	F B	C	D
1.	■				26.					51.					76.				
2.		■			27.					52.					77.				
3.		■			28.					53.					78.				
4.	■				29.					54.					79.				
5.		■			30.					55.					80.				
6.	■				31.					56.					81.				
7.		■			32.					57.					82.				
8.	■				33.					58.					83.				
9.		■			34.					59.					84.				
10.	■				35.					60.					85.				
11.	■				36.					61.					86.				
12.	■				37.					62.					87.				
13.	■				38.					63.					88.				
14.				■	39.					64.					89.				
15.		■			40.					65.					90.				
16.					41.					66.					91.				
17.					42.					67.					92.				
18.					43.					68.					93.				
19.					44.					69.					94.				
20.					45.					70.					95.				
21.					46.					71.					96.				
22.					47.					72.					97.				
23.					48.					73.					98.				
24.					49.					74.					99.				
25.					50.					75.					100.				

*Show work for problems on back of answer sheet.

ANSWER KEY
UNIT 8

A. KNOW YOUR DEFINITIONS

1. (subjective answer)
2. (subjective answer)
3. (subjective answer)
4. (subjective answer)
5. (subjective answer)
6. (subjective answer)

B. QUEST ACTIVITY

1. conductor
2. insulator
3. insulator
4. conductor
5. insulator
6. conductor
7. semiconductor
8. insulator
9. insulator
10. conductor
11. semiconductor
12. conductor
13. insulator
14. insulator
15. conductor
16. insulator
17. insulator
18. conductor
19. insulator
20. conductor
21. to allow current to flow.
22. to block current flow.

23A. silver

23B. gold

23C. copper

24. copper
25. free
26. germanium
27. insulation
28. easy to form
29. flexible
30. load will draw considerable current.

ELECTRICITY / ELECTRONICS

CURRICULUM GUIDE
INSTRUCTIONAL MODULE

UNIT IX
THE ELECTRICAL TEAM
LEVEL II

STATE OF CALIFORNIA
DEPARTMENT OF EDUCATION

NAME____________________
DATE STARTED____________
DATE COMPLETED_________

BY
R. E. LILLO
N. S. SOFFIOTTO

Title of Unit: The Electrical Team

Time Allocation: 2 weeks

Unit Goal:

To investigate and transmit those competencies related to identifying fundamental electrical quantities and their units of measurement, and to attain student competence in the measurement techniques necessary for monitoring these quantities.

Unit Objectives:

The student will be able to:

1. identify and differentiate between the basic types of electrical quantities and their corresponding units of measurements.
2. compare and contrast the application of meters used in measuring simple electrical quantities.
3. demonstrate the proper techniques to employ when reading a typical meter scale, and to explain the necessity of an accurate measurement.

Evaluation:

The student will demonstrate his/her competence in terms of these measurable objectives based upon individual instructors acceptable performance criteria, which utilizes a combination of written, oral, and laboratory testing procedures.

Instructor References:

Electricity One-Seven. Harry Mileaf, Hayden Book Company, Inc., 1976. Chapters: Electricity Two and Electricity Five.

Elements of Electronics. Henry V. Hickey and William M. Villines, McGraw-Hill Book Co., 1970. Chapters: 3, 5, 8, 9, 12, and 13.

Understanding Electricity and Electronics. Peter Buban and Marshall L. Schmitt, McGraw-Hill Book Co., 1975. Units: 2, 9, 10, and 11.

Overview:

Several basic competencies are introduced in this unit, and these competencies can serve as a solid foundation for succeeding technical units throughout this level as well as future levels if they are acquired.

The unit should be presented carefully in terms of content. First, the idea that must be stressed is that electrical quantities are indeed necessary to define and that these quantities operate as a team when performing within a circuit. Once the definitions and functions have been firmly established in the mind of the student, it is relatively easy to associate letter symbols or units of measurement with the proper quantity.

The next major topic should deal with measuring procedures and meter usage. Look out......because this area of instruction may be critical for successful laboratory work, and without adequate instruction meter mortality will be sky high.

Suggested Presentation Hints/Methodology:

Follow the instructional module unit outline as a basic skeleton for curriculum presentation, however, note the following:

1. Be aware when explaining simple terminology that very often first exposure to technical expressions can be misunderstood by the student. Spend a significant amount of time reviewing what these terms, voltage, current, and resistance mean, then briefly explain their relationship with each other.
2. Do not be afraid to use the art of repetition as a means to drill or impress students with specific units of measurement or letter symbols. Use the blackboard also as an effective vehicle by listing a variety of terms and/or units, then let the students match up the correct pairs.
3. Meters and measurement are vital instructional concepts especially for future laboratory work so it is worthwhile to; reemphasize major instructional points periodically, illustrate methods of meter connections, utilize managers or advance students to assist in supervision and instruction, and coordinate measurement activities so that electrical quantities are not measured in succession - E, I, and R. Careful presentation of this topic will enable both instructor/students an opportunity to maintain a positive laboratory attitude. Caution - since time allocation is always so critical in the classroom, focus your attention on meters common to your laboratory and note at this level, many instructors completely omit laboratory exercises based on ammeter usage because of obvious problems in misuse.

Supplemental Activities and Demonstrations:

1. Write, using school stationary, and ask for free school visual aides or handout materials related to meters and measurement. Addresses are easy to obtain from large meter manufacturers such as; Simpson, Triplett, Weston, RCA, by simply contacting your local electronic parts dealer. Don't be shy, ask for classroom sets and if less arrives make a bulletin board display-Good Luck!
2. Prior to any discussion on meter reading, budget an appropriate amount of time for instructing educationally disadvantaged students in terms of ruler or scale reading. Believe it or not many average students have difficulty reading an ordinary measureing device, so use this as a beginning point, then, transfer this kind of measurement reading to meter scales and their divisions.
3. Demonstrate a variety of meters, however, try to include small panel meters, meter instruments and digital measuring devices.

Instructional Module Contents:

1. Unit Outline (overhead)
2. Pre-Post Test (keyed)
3. Technical Glossary
4. Worksheet (vocabulary) - Glossary Cryptics
5. Worksheet - Shop Meter
6. Worksheet - Reading Meter Scales
7. Quest Activities
8. Informational Handout (The Electrical Team)
9. Informational Handout (Procedures in Reading a Meter)
10. Informational Handout (How to Use a Meter to Measure Voltage or Resistance)
11. Unit Module Answer Keys

IX. The Electrical Team

- A. Basic Electrical Quantities
  - 1. Voltage
  - 2. Current
  - 3. Resistance
- B. Letter Symbols
- C. Units of Measurements
- D. Meters for Measuring Electrical Quantities

Test Number _____

LII-U9

UNIT EXAM

THE ELECTRICAL TEAM

IMPORTANT-

Indicate your response on the answer sheet only. Fill in the box corresponding to the correct answer to each question - there is only one correct answer for each question.

1. The letter symbol for voltage is V. (T-F)

2. Voltage and electromotive force mean the same thing. (T-F)

3. The symbol ∞, which appears on some ohmmeter scales, means infinity. (T-F)

4. Zeroing a meter is necessary to achieve accurate measurements. (T-F)

5. Electron flow in a DC circuit is always from negative to positive. (T-F)

6. To measure a DC voltage drop, the meter is connected across a resistor and polarity must be observed. (T-F)

7. When taking a resistance measurement, the circuit being tested may be left on, or turned off. (T-F)

8. Both current and voltage move or flow through a circuit. (T-F)

9. The function switch on a meter is used to set the needle or pointer to zero. (T-F)

10. When measuring an unknown value of voltage, the meter range switch should be set in its highest position. (T-F)

11. The basic unit of measurement for voltage is the:
(A) watt, (B) ohm, (C) ampere, (D) volt.

12. The letter symbol for current is:
(A) C, (B) I, (C) A, (D) E.

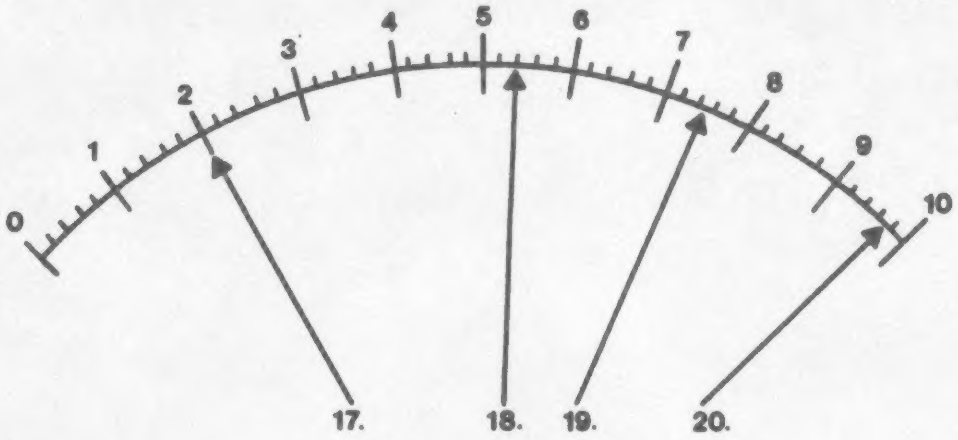
13. "Ω" is the electrical symbol for the:
(A) volt, (B) ampere, (C) resistor, (D) ohm.

14. The orderly flow of electrons through a circuit is known as:
(A) current, (B) electromotive force, (C) resistance, (D) power.

15. The electrical quantity which opposes the flow of electrons through a circuit is called:
(A) voltage, (B) resistance, (C) ohm, (D) current.

16. A multimeter is generally able to measure:
(A) voltage, (B) current, (C) resistance, (D) all of the above.

For questions 17, 18, 19, and 20, read and record the value indicated by each pointer/scale combination.



17. ☐
18. ☐
19. ☐
20. ☐

Name: ____________________

Date: ____________________

Period: ____________________

TECHNICAL GLOSSARY

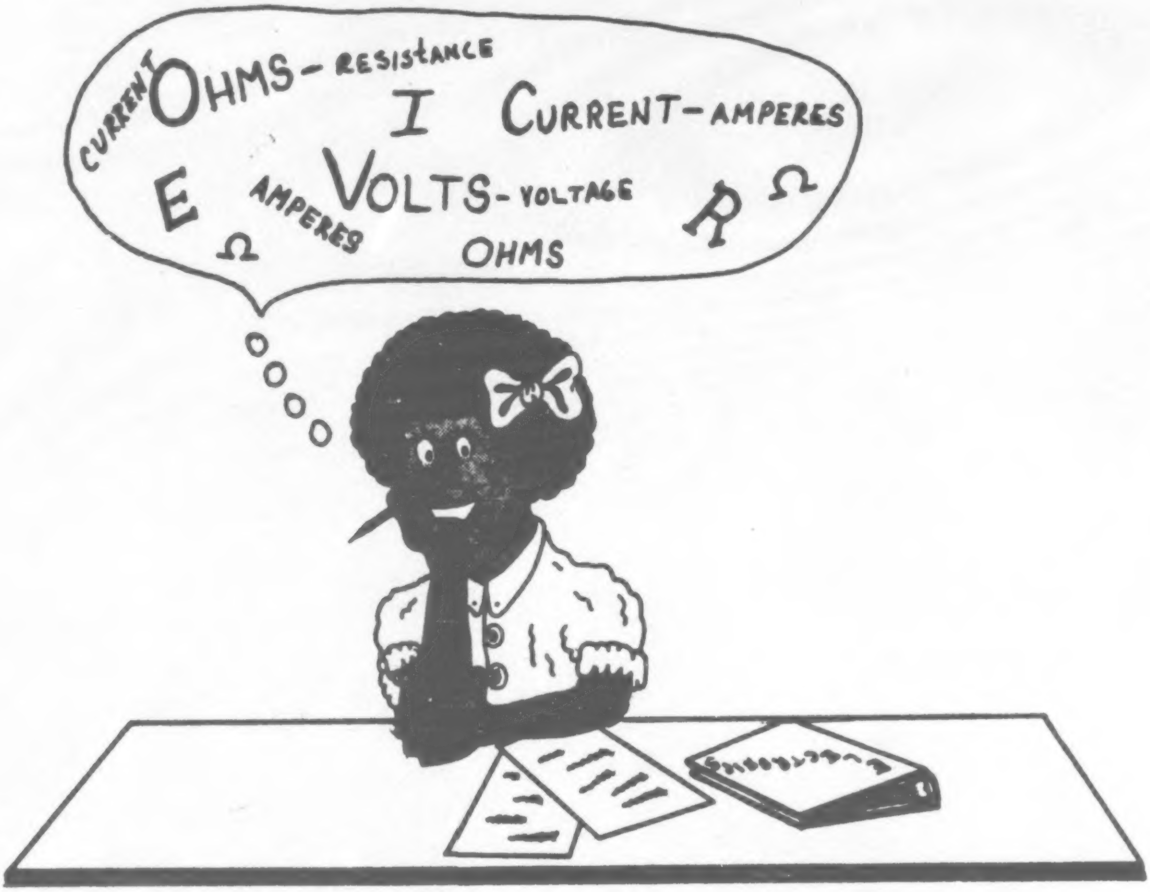
AMMETER:	An instrument designed to measure electrical current flow. Symbol: —Ⓐ—
AMPERE:	The basic unit of measurement for current flow. Letter symbol: A
CURRENT:	The orderly flow of electrons through a circuit. Current is measured in the basic unit amperes or amps. However, milliamperes and microamperes are also used as units of measurement. Letter symbol: I
DEFLECTION:	The movement of the meter pointer from the zero position.
DIGITAL MULTIMETER:	A multimeter whose input or measured value is displayed directly as illuminated digits or numbers. Abbrev. DMM
ELECTROMOTIVE FORCE:	The pressure that causes electrons to move through a circuit and also referred to as voltage. Letter symbol: E, Abbrev: EMF
FUNCTION SWITCH:	A meter control used to select the electrical quantity (voltage, current, or resistance) to be measured.
INFINITY:	An extremely large value that continues indefinitely. Symbol:
MECHANICAL ZERO:	An adjustment to the meter movement which mechanically sets the meter pointer on zero. This adjustment is necessary for accurate measurement.
METER:	A device to measure electrical quantities; such as voltage, resistance, frequency, etc. Symbol: —Ⓜ— Letter symbol: M
MULTIMETER:	A meter designed to measure more than one electrical quantity. Most multimeters can measure AC and DC voltage, AC and DC current, and resistance.
NEEDLE:	The indicating device on a meter, sometimes called the pointer. The needle and scale are used in conjunction to read the indicated value.
OHM:	The basic unit of measurement for resistance. Letter symbol: Ω
OHMMETER:	An instrument used to measure electrical resistance in ohms. Symbol: —(Ω)—

Name: ____________________

Date: ____________________

Period: ____________________

POLARITY:	The property of a device or circuit determining the direction in which current flows. The quality of having two opposite charges, one positive (+) and the other negative (-). Polarity can also refer to the quality of having two opposite magnetic poles, one north and one south.
RANGE SWITCH:	A basic meter control used to select the maximum value which the meter can measure. Many times the range switch is used as a multiplier.
RESISTANCE:	A measure of the opposition that a component or circuit offers to the flow of an electric current. Resistance is measured in the basic unit ohms, however kilohm, and megohms are also used as units of measurement. Letter symbol: R
SCALE:	Line or arc found on an instrument face with graduations or increments that have an assigned value.



SCORE:

GRADE:

Name: ______________

Date: ______________

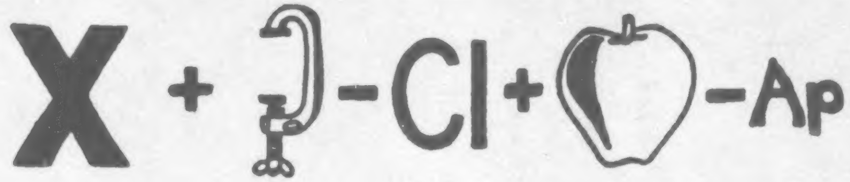
Period: ______________

WORKSHEET

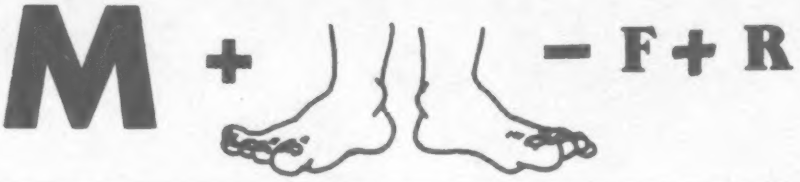
GLOSSARY CRYPTICS

Decode the cryptic messages below to identify the electronic term.

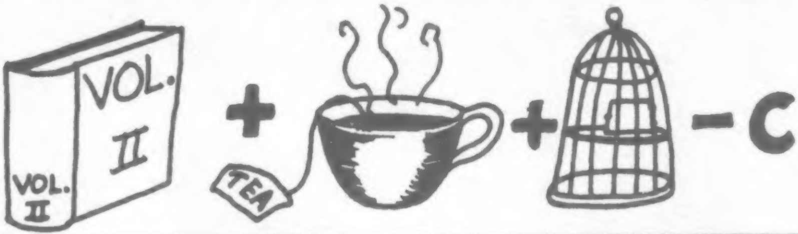
EXAMPLE:

A. 

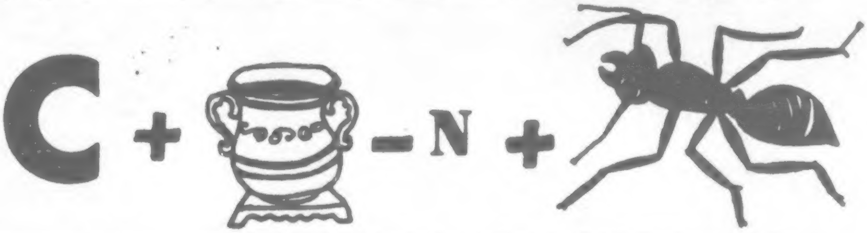
A. EXAMPLE

1. 

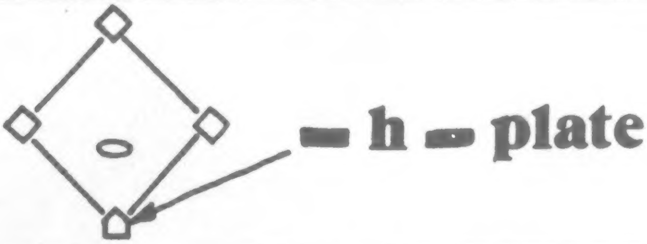
1. ☐

2. 
VOL. II
VOL. II
+
TEA
+
- C

2. ☐

3. 

3. ☐

4. 

4. ☐

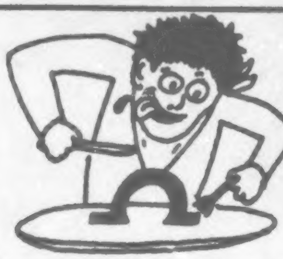
Name: ____________________

Date: ____________________

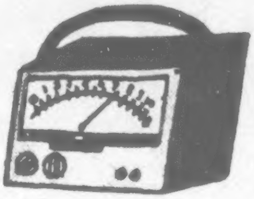
Period: ____________________

CONTINUE WITH THESE CRYPTICS:

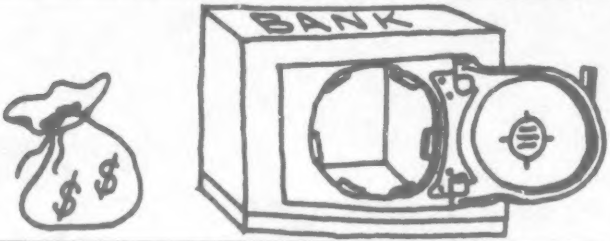
5.



6. $\begin{array}{r} 7 \\ \times\ 3 \\ \hline 21 \end{array}$ − ply +

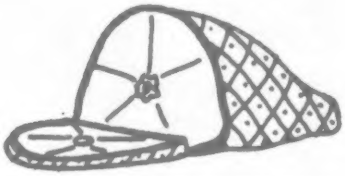


7.

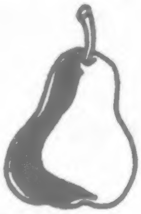


8.

A.



− h +



5. ☐

6. ☐

7. ☐

8. ☐

SCORE:

GRADE:

Name: ____________

Date: ____________

Period: ____________

WORKSHEET

SHOP METER

In the space provided, make an accurate drawing of the shop meter. Label all controls and terminals.

Shop Meter

In the space provided, describe the purpose of the shop meter - why is it such an important piece of test equipment?

SCORE:

GRADE:

Name: ____________________

Date: ____________________

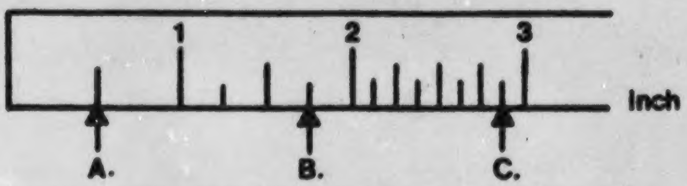
Period: ____________________

WORKSHEET

READING METER SCALES

Read and record the value indicated by the scale/pointer combinations below:

1.

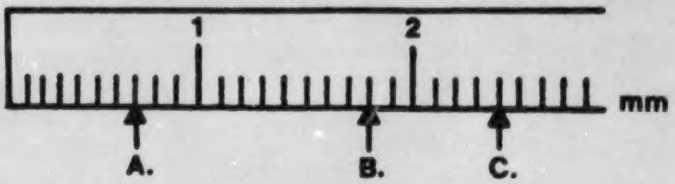

1
2
3
inch
A.
B.
C.

1A. ☐

1B. ☐

1C. ☐

2.

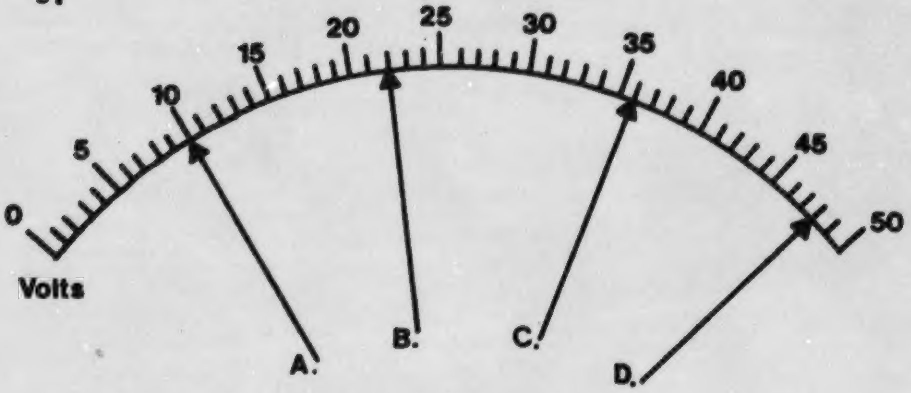


2A. ☐

2B. ☐

2C. ☐

3.


0
5
10
15
20
25
30
35
40
45
50
Volts
A.
B.
C.
D.

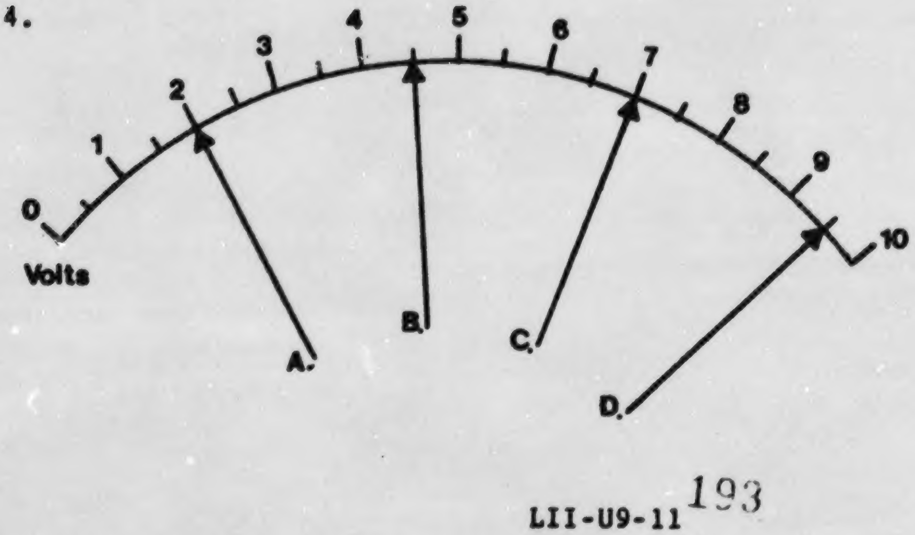
3A. ☐

3B. ☐

3C. ☐

3D. ☐

4.


0
1
2
3
4
5
6
7
8
9
10
Volts
A.
B.
C.
D.

4A. ☐

4B. ☐

4C. ☐

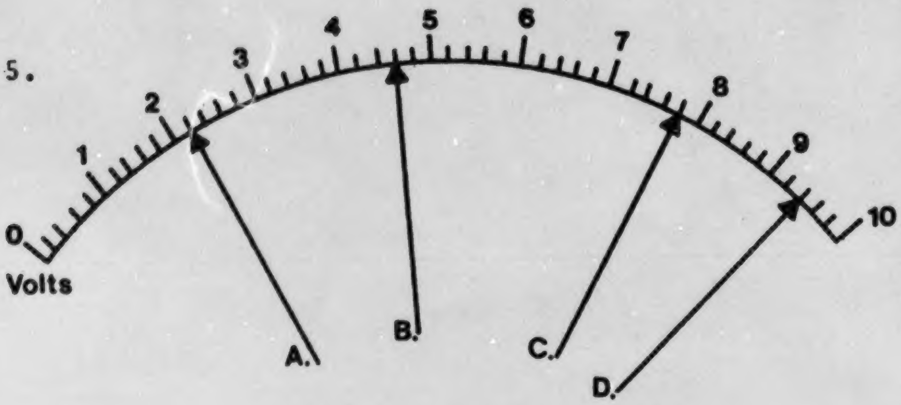
4D. ☐

Name: ____________________

Date: ____________________

Period: ____________________

5.


0
1
2
3
4
5
6
7
8
9
10
Volts
A.
B.
C.
D.

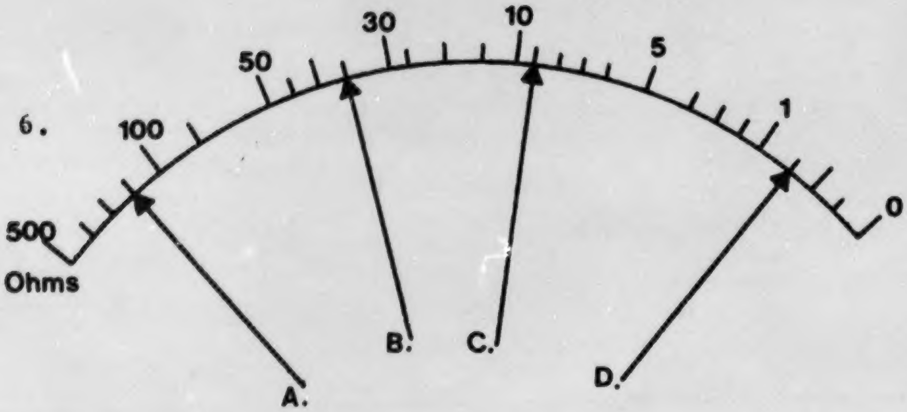
5A. ☐

5B. ☐

5C. ☐

5D. ☐

6.


500
100
50
30
10
5
1
0
Ohms
A.
B.
C.
D.

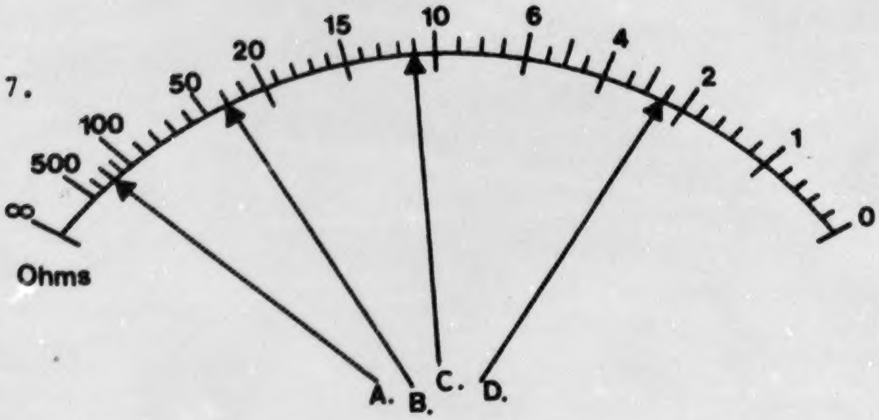
6A. ☐

6B. ☐

6C. ☐

6D. ☐

7.


∞
500
100
50
20
15
10
6
4
2
1
0
Ohms
A.
B.
C.
D.

7A. ☐

7B. ☐

7C. ☐

7D. ☐

SCORE:

GRADE:

Name: ____________________

Date: ____________________

Period: ____________________

WORKSHEET

QUEST ACTIVITY

"UNIT 9"

MATCHING #1

1. Voltage
2. Resistance
3. Ampere
4. Current
5. Volt
6. Ohm

A. V
B. O
C. I
D. E
E. A
F. R
G. C
H. Ω

1. ☐
2. ☐
3. ☐
4. ☐
5. ☐
6. ☐

MATCHING #2

7. Ammeter
8. Voltmeter
9. Ohmmeter
10. Multimeter
11. Must be connected across the component.
12. All power must be off in circuit.
13. Selects mode of operation; what is to be measured.
14. Sets maximum value that can be measured.

A. Measures resistance in ohms.
B. Function switch
C. Measures voltage in volts
D. Voltmeter
E. Ohmeter
F. Measures current in amps.
G. Measures voltage in volts, current in amps and resistance in ohms.
H. Range switch

7. ☐
8. ☐
9. ☐
10. ☐
11. ☐
12. ☐
13. ☐
14. ☐

- - - - - - - - - - - - - - - - - - - -

15. The basic unit for measuring electrical current is the __________. 15. ☐
16. The force or pressure which causes electrons to move through a circuit is called __________. 16. ☐
17. __________ is the actual orderly flow of electrons through a circuit. 17. ☐
18. The basic unit of measurement for resistance is the __________. 18. ☐
19. __________ is a measurement of the opposition that a component or circuit offers to current flow. 19. ☐
20. Voltage is measured in the basic unit __________. 20. ☐

Name: ____________________

Date: ____________________

Period: ____________________

21. When measuring an unknown value of voltage, the range switch should be set to its __________ position. 21.

22. What is the purpose of the zero adjust control on a meter?

23. Explain what is meant by the expression "observing polarity."

24. Draw a sketch which illustrates how a meter should be connected to measure voltage.

25. Draw a sketch showing how to connect a meter to measure resistance.

Name: ______________________

Date: ______________________

Period: ______________________

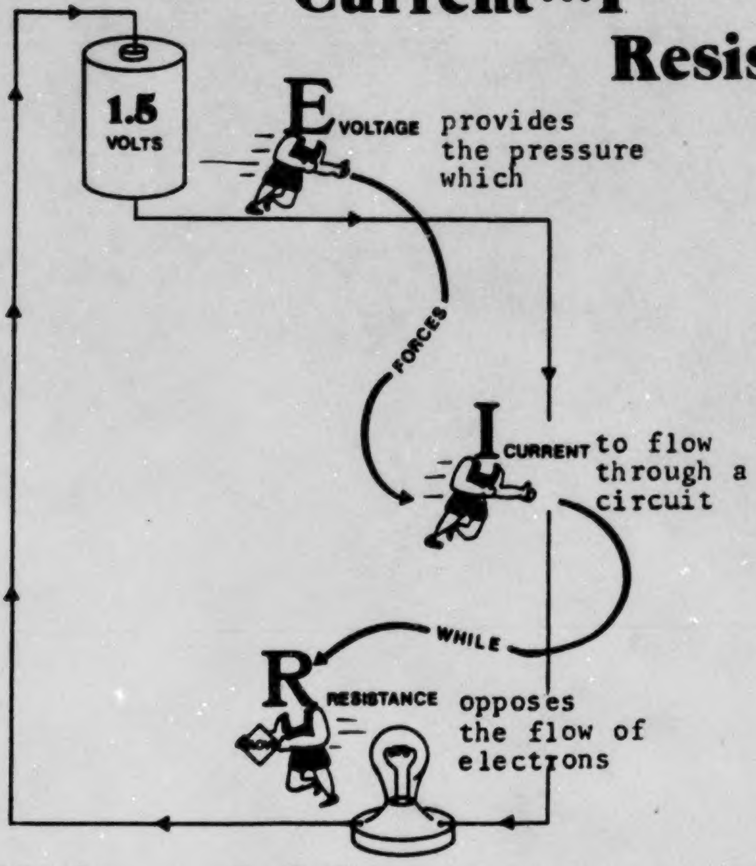
INFORMATIONAL HANDOUT

THE ELECTRICAL TEAM

Voltage···E

Current···I

Resistance···R


1.5
VOLTS
E VOLTAGE provides the pressure which
FORCES
I CURRENT to flow through a circuit
WHILE
R RESISTANCE opposes the flow of electrons

Units of Measurement

Voltage is measured in the basic unit	*volts*	**(V)**
Current is measured in the basic unit	*amperes*	**(A)**
Resistance is measured in the basic unit	*ohms*	**(Ω)**

Name: ____________________

Date: ____________________

Period: ____________________

INFORMATIONAL HANDOUT

PROCEDURES IN READING A METER

The sequence below should be utilized as a reference guide when reading a meter.

1. CHECK THE FUNCTION SWITCH.

   Determine what quantity is being measured.

2. LOCATE THE METER SCALE.

   Find the scale that matches the quantity set on the function switch.

3. READ THE SCALE.

   Read the value where the pointer comes to rest across the scale divisions. Be sure you are looking directly at the scale to avoid parallax problems.

4. CHECK THE RANGE SWITCH.

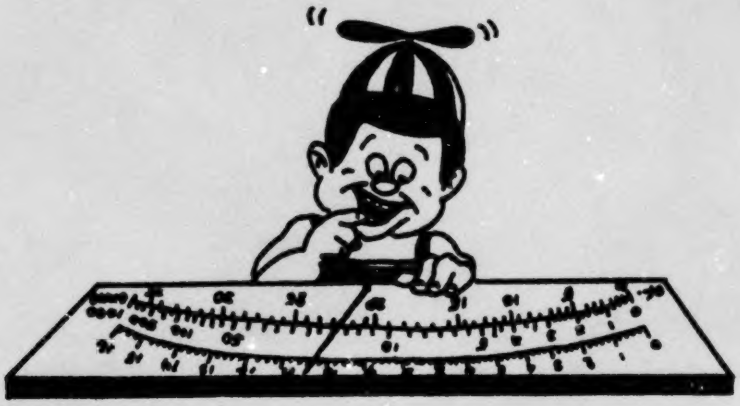
   Identify the range position, then determine the multiplier.

5. MULTIPLY THE SCALE READING.

   Multiply the reading on the scale by the multiplier indicated by the range switch.

6. THAT'S ALL THERE IS TO IT - YOU HAVE READ THE METER.

   When you record the value you have read, be sure to also record the quantity measured - volts, ohms, or amperes.



Name: ____________________

Date: ____________________

Period: ____________________

INFORMATIONAL HANDOUT

HOW TO USE A METER TO MEASURE VOLTAGE OR RESISTANCE

1. SET THE FUNCTION SWITCH

Adjust the function switch for the electrical quantity you want to measure.

Identify the quantity being measured - DC voltage, AC voltage, or resistance - and select the one proper function switch position.

2. SET THE RANGE SWITCH

Caution must be used when setting the range switch. When using the voltage functions be sure the range switch is set in a high enough position so you will not peg the meter.

HINT: If measuring an unknown value of voltage set the range switch to the highest position.

In the ohms function, the range position is not critical. Select the position that will move the pointer closest to mid-scale.

3. ZERO THE METER

Be sure to zero the meter. This will insure an accurate measurement.

ZEROING PROCEDURE:

a. If available, adjust the "mechanical zero" so that the meter indicates zero. This adjustment is made when the meter is off.

b. Zeroing for voltage. Turn the meter on, and allow enough time for stabilization. Connect the test leads together, and use the zero adjust control to set the indicator to zero.

c. Zeroing for resistance. After your meter has stabilized, connect the test leads together and adjust for zero resistance with either the zero adjust or ohms adjust (depending upon the type of meter). Disconnect leads and adjust for infinity. The last two steps may have to be repeated to achieve accurate zeroing.

4. CONNECT THE METER INTO THE CIRCUIT

A. Voltage connection

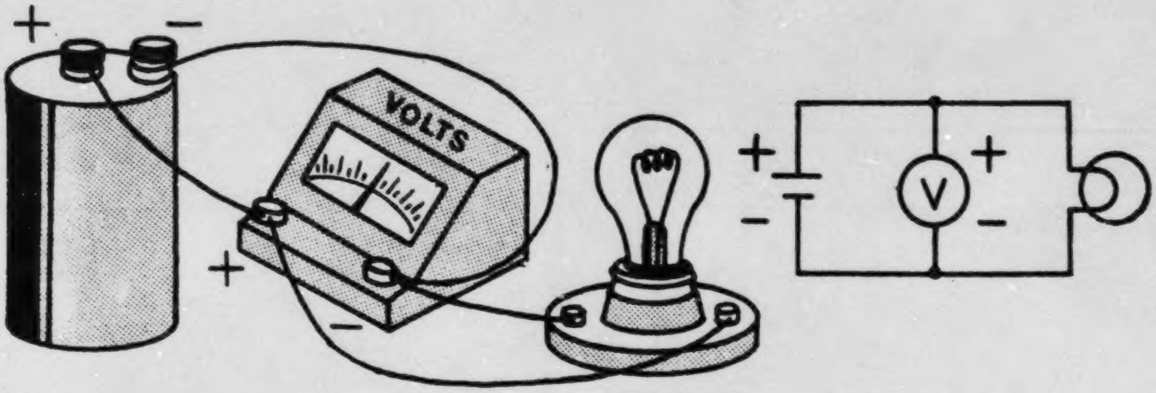
When measuring voltages (AC or DC) the meter must be connected in parallel with the circuit.

Name: ____________________

Date: ____________________

Period: ____________________

Also, be sure to observe polarity when measuring DC voltages - the positive lead of the meter must be connected to the positive side of the circuit. The negative lead must be connected to the negative side of the circuit.



NOTE:

If the reading is below the usable portion on the voltage scale the range switch may be stepped down one position for a more accurate reading.

B. Resistance connection

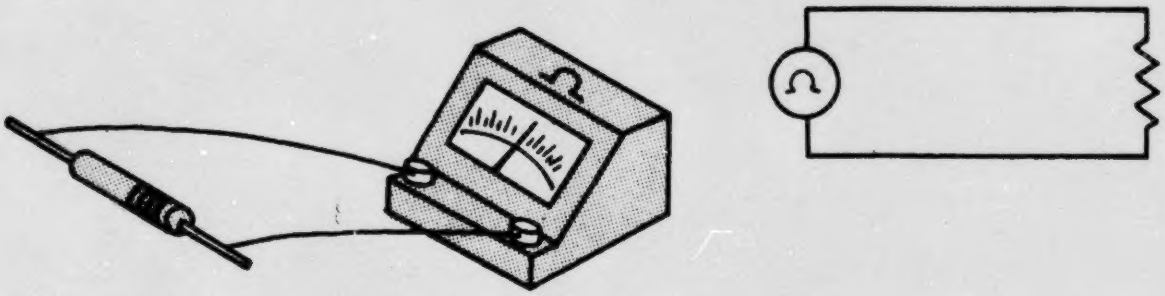
When measuring resistance the meter must be connected in series with the resistance being measured.

Be sure that there is no power applied to the circuit when measuring resistance.

The best way to accurately measure the resistance of a resistor is to remove it from the circuit.

The ohm meter is a valuable instrument for checking continuity of both components and circuits.

Polarity need not be observed in this kind of measurement.



NOTE:
An accurate reading will be achieved if the needle is close to the middle of the scale. Vary the range switch to locate the position where the pointer moves closest to the center scale.

Name: ____________________

Date: ____________________

Period: ____________________

5. READ THE METER

Read the value indicated on the meter. Refer to your handout - "Steps in Reading a Meter" for step by step procedure.

6. TROUBLESHOOTING HINTS

a. Common causes of meter malfunctions.
   1) open or damaged test leads
   2) weak or dead batteries
   3) blown fuse or reset
   4) damaged meter circuit
   5) improper meter connection

b. Be sure to recheck your zero adjustments if you have changed the function or range switch.

c. CAUTION - do not touch the metal tips on the test leads when making measurements.

d. Double check all connections before turning on power or taking measurements.

SCORE:.

GRADE:

Name: ______________________

Date: ______________________

Period: ______________________

ANSWER SHEET

EXAM LII U9

	T	F				T	F				T	F				T	F		
	A	B	C	D		A	B	C	D		A	B	C	D		A	B	C	D
1.		■			26.					51.					76.				
2.	■				27.					52.					77.				
3.	■				28.					53.					78.				
4.	■				29.					54.					79.				
5.	■				30.					55.					80.				
6.	■				31.					56.					81.				
7.		■			32.					57.					82.				
8.		■			33.					58.					83.				
9.		■			34.					59.					84.				
10.	■				35.					60.					85.				
11.				■	36.					61.					86.				
12.		■			37.					62.					87.				
13.				■	38.					63.					88.				
14.	■				39.					64.					89.				
15.		■			40.					65.					90.				
16.				■	41.					66.					91.				
17.	2				42.					67.					92.				
18.	5.4				43.					68.					93.				
19.	7.5				44.					69.					94.				
20.	9.7				45.					70.					95.				
21.					46.					71.					96.				
22.					47.					72.					97.				
23.					48.					73.					98.				
24.					49.					74.					99.				
25.					50.					75.					100.				

*Show work for problems on back of answer sheet.

ANSWER KEY
UNIT 9

A. GLOSSARY CRYPTIC

1. meter
2. voltage
3. current
4. ohm
5. ohmmeter
6. multimeter
7. volt
8. ampere

B. SHOP METER

(subjective evaluation)

C. READING METER SCALES

1A. 1/2 inch
1B. 1 3/4 inch
1C. 2 7/8 inch
2A. 7 mm
2B. 1.8 cm
2C. 2.4 cm
3A. 10 volts
3B. 22 volts
3C. 36 volts
3D. 48 volts
4A. 2 volts
4B. 4.5 volts
4C. 7 volts
4D. 9.5 volts
5A. 2.2 volts
5B. 4.6 volts
5C. 7.8 volts
5D. 9.4 volts
6A. 200 ohms
6B. 35 ohms
6C. 9 ohms
6D. .75 ohms
7A. 300 ohms
7B. 40 ohms
7C. 11 ohms
7D. 2.5 ohms

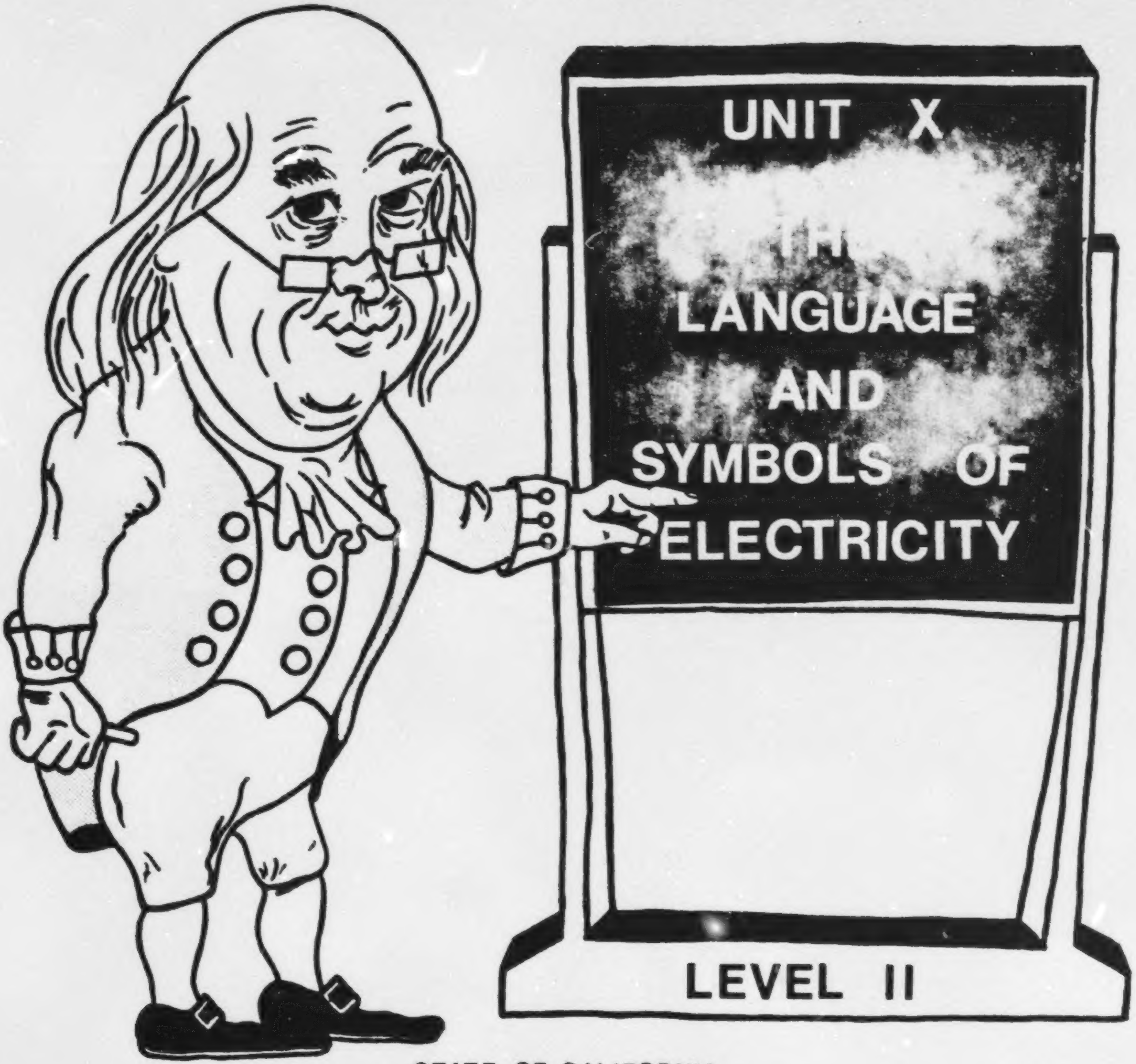
D. QUEST ACTIVITY

1. D
2. F
3. E
4. C
5. A
6. H
7. F
8. C
9. A
10. G
11. D
12. E
13. B
14. H

15. ampere
16. voltage
17. current
18. ohm
19. resistance
20. volt
21. highest (maximum)
22. adjust the meter to 0 on the scale for voltage and current.
23. connecting the meters' negative terminal to negative polarity and the positive meter terminal to positive polarity.
24. a voltmeter connected across the load with power applied to the circuit.
25. an ohmmeter connected across a load with no power applied to the circuit.

ELECTRICITY / ELECTRONICS

CURRICULUM GUIDE
INSTRUCTIONAL MODULE


UNIT X
THE
LANGUAGE
AND
SYMBOLS OF
ELECTRICITY
LEVEL II

STATE OF CALIFORNIA
DEPARTMENT OF EDUCATION

NAME____________________
DATE STARTED__________
DATE COMPLETED________

BY
R. E. LILLO
N. S. SO[illegible]OTTO

STATE ELECTRICITY/ELECTRONICS CURRICULUM GUIDE
INSTRUCTOR'S GUIDE TO ACCOMPANY LEVEL II UNIT #10

Title of Unit: The Language and Symbols of Electricity

Time Allocation: 1 week

Unit Goal:

To integrate with previously taught competencies those new competencies that would enable immediate recognition of symbols, designations, or terms commonly utilized in schematic diagrams or technical data sheets.

Unit Objectives:

The student will be able to:

1. read and draw a number of technical symbols that represent components commonly utilized in basic circuits.
2. identify a variety of letter designations which may accompany a circuit symbol but are not themselves a part of the symbol.
3. distinguish and interpret a simple schematic diagram.

Evaluation:

The student will demonstrate his/her competence in terms of these measurable objectives based upon individual instructors acceptable performance criteria, which may utilize a combination of written, oral, and laboratory testing procedure.

Instructor References:

Electronics Assembly and Fabrication Methods. Duarte and Duarte, McGraw-Hill Book Co., 1973. Chapters: 2, 3, and 4.

Technical Electricity and Electronics. Peter Buban and Marshall L. Schmitt, McGraw-Hill Book Co., 1977. Units 29 and 30.

Understanding Electricity and Electronics. Peter Buban and Marshall L. Schmitt, McGraw-Hill Book Co., 1975. Unit 3.

Overview:

The main theme of this unit is that symbols are a vital part of the technical language used for conveying information in the industrial community.

The unit should be introduced by showing the logical reasons that led to the development and use of graphical illustrations.

The next topics should then deal with basic symbols, letter designations, and organization of symbols to create a schematic diagram. The schematic diagram should be considered as a vehicle that transmits valuable technical data to the skilled reader.

This unit should conclude with the student realizing that further explanation of new symbols, and electrical terms will continue throughout this level. A variety of appropriate exercises and laboratory experiments and or projects should be coordinated with all unit topics when feasible.

Suggested Presentation Hints/Methodology:

Follow the instructional module unit outline as a basic skeleton for curriculum presentation, however, note the following:

1. Teachers often do not instruct formally in terms of a unit on schematic symbols, yet, it has been included here so that it will serve as a means to enhance student technical comprehension. Try to physically associate parts with their symbols in an effort to assist students immediately in familiarity with electronic components. At this point the student may become aware of various marking on the body of components and these identifications or designations can be discussed.
2. Have student respond to symbol exercises if possible, with color pencils, markers, or felt pens. Illustrations seem to be of higher quality when generated in this format.
3. Frequently, symbols are discussed by instructors without mention of standards, recommended drawing practices, application of symbols, and diagram types. These topics are areas which contain essential competencies in terms of the industrial world and should be emphasized. An inexpensive teacher resource for samples of many graphic representation would be a television repair photofact folder.

Supplemental Activities and Demonstrations:

1. A useful blackboard activity to impress slower students with schematic symbols is for the instructor to pick out an assortment of components for the class to view. Out of this selection have the class name those that actually look like the symbols they represent. Use the blackboard to list the result and verbally emphasize that indeed many schematic symbols are definitely symbolic pictures.
2. An activity which teaches several concepts, yet enjoyable, would be to have students send away for a free parts catalog. Once the student has a catalog the activities are bountiful, for example; cut pictures of parts and summarize functions, list letter designations, and draw circuit symbols.

Instructional Module Contents:

1. Unit Outline (overhead)
2. Pre-Post Test (keyed)
3. Technical Glossary
4. Worksheet (vocabulary) - Word Decoding
5. Worksheet - Electrical Terms and Symbols
6. Quest Activities
7. Informational Handout (Schematic Symbols)
8. Unit Module Answer Keys

X. The Language and Symbols of Electricity

A. Electrical Circuit Diagrams
    1. Schematic symbols

    2. Letter designations

    3. Schematic diagrams

B. Electrical Terms

Test Number ______

LII-U10

UNIT EXAM

THE LANGUAGE AND SYMBOLS OF ELECTRICITY

IMPORTANT-

Indicate your responses on the answer sheet only. Fill in the box corresponding to the correct answer to each question - there is only one correct answer for each question.

1. On a schematic diagram, the components are shown as graphic symbols. (T-F)

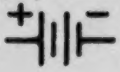
2. The dot symbol on a schematic diagram is used to show that wires are electrically connected together. (T-F)

3. Abbreviations, or letter designations are used to simplify component identification. (T-F)

4. A typical reference designation uses a number/letter code such as 3_R to designate resistor #3. (T-F)

5. Schematic symbols are used to illustrate electronic terms. (T-F)

Identify the schematic symbols drawn below.

6. 

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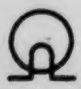
7. 
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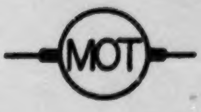
8. 

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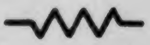
9. 
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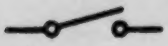
10. 
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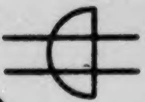
11. 
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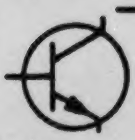
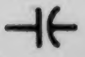
12. 
____

13. 
____

Identify the abbreviations or letter designations listed below.

14. Ω________________________

15. T________________________

16. DC________________________

17. L________________________

18. Q________________________

19. D________________________

20. GND________________________

Name: ____________________

Date: ____________________

Period: ____________________

TECHNICAL GLOSSARY

ABBREVIATION:	The expression of a word or term, in shortened form, usually by using representative letters. Example: The term direct current is abbreviated with the letters DC.
COMPONENT:	An electronic part.
CONNECTION:	The junction or joining point of several conductors or components in an electrical circuit.
ELECTRICAL TERM:	A word or phrase which describes an electrical quantity, unit of measurement, component, or electrical action.
LETTER IDENTIFICATION:	A letter used to designate a particular type of electronic component. Example: The letter identification for a capacitor is C.
NUMERICAL VALUE:	The rating or value of a component expressed in its unit of measurement. The numerical value of a one thousand ohm resistor for example can be expressed as 1000 or 1k.
REFERENCE DESIGNATION:	The symbol used to represent components in a circuit diagram. The reference designation combines a letter identification and a subscript, to identify one particular component. The designation for resistor three on a schematic diagram would be R_3.
SCHEMATIC DIAGRAM:	A special type of drawing used in electronics to represent circuit components and connections. This type of diagram uses simplified symbols to show electrical connections, but does not show the physical layout or part structure.
SCHEMATIC SYMBOL:	A symbolic representation used to depict an electronic component and often referred to as a graphic symbol.
SUBSCRIPTS:	Small identifying numbers or letters written slightly to the right of and below the quantity being identified. Example: In the expression R_3, 3 is the subscript.

SCORE:

GRADE:

Name: ____________________

Date: ____________________

Period: ____________________

WORKSHEET

VOCABULARY - WORD DECODING

The words below have little meaning until they are decoded. Each letter actually represents another letter in the alphabet. Your task is to break the code and decode each word. The example will get you started by providing seven decoded letters. The code remains the same throughout the worksheet.

EXAMPLE: A. H A H J S U D J D S N E L E C T R I C I T Y	A. ELECTRICITY
1. S H U Z _ _ _ _	1.
2. T N Z K X A _ _ _ _ _ _	2.
3. J X Z W X Y H Y S _ _ _ _ _ _ _ _ _	3.
4. J X Y Y H J S D X Y _ _ _ _ _ _ _ _ _ _	4.
5. T R K T J U D W S T _ _ _ _ _ _ _ _ _ _	5.
6. L K K U H Q D L S D X Y _ _ _ _ _ _ _ _ _ _ _ _	6.
7. Y R Z H U D J L A Q L A R H _ _ _ _ _ _ _ _ _ _ _ _ _ _	7.
8. T J E H Z L S D J I D L F U L Z _ _ _ _ _ _ _ _ _ _ _ _ _ _ _ _	8.
9. A H S S H U D I H Y S D G D J L S D X Y _ _ _ _ _ _ _ _ _ _ _ _ _ _ _ _ _ _ _ _	9.
10. U H G H U H Y J H I H T D F Y L S D X Y _ _ _ _ _ _ _ _ _ _ _ _ _ _ _ _ _ _ _ _	10.

SCORE:

GRADE:

Name: ____________

Date: ____________

Period: ____________

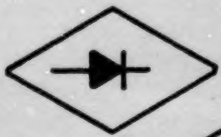
WORKSHEET

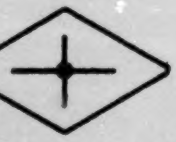
ELECTRICAL TERMS AND SYMBOLS

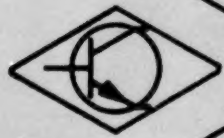
A. Draw in the correct schematic symbol for the following electronic components.

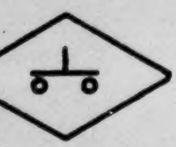
1. Cell:
2. Ammeter:
3. Fixed value capacitor:
4. Iron core transformer:
5. Fuse:
6. Incandescent lamp:
7. Single pole single throw switch:
8. DC motor:
9. Thermocouple:
10. Adjustable resistor:

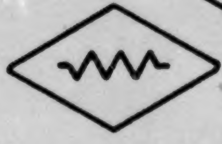
B. Identify the following graphic symbols:

11.  . . . . ____________

12.  . . . . . . ____________

13.  . . . . ____________

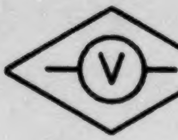
14.  . . . . . . ____________

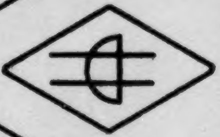
15.  . . . . ____________

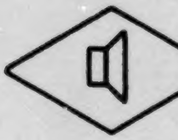
Name: ____________________

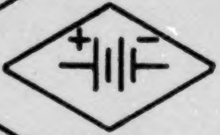
Date: ____________________

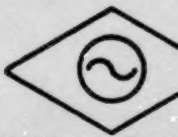
Period: ____________________

16.  . . . . ____________________

17.  . . . . . . ____________________

18.  . . . . ____________________

19.  . . . . . . ____________________

20.  . . . . ____________________

C. Give the letter designation or abbreviation for the following.		D. Identify the following letter designations or abbreviations.	
21. current:	____	31. L:	____________________
22. ground:	____	32. DC:	____________________
23. milli:	____	33. DPDT:	____________________
24. ohm:	____	34. Q:	____________________
25. positive:	____	35. D:	____________________
26. capacitor:	____	36. LP:	____________________
27. battery:	____	37. T:	____________________
28. switch:	____	38. A:	____________________
29. light emitting diode:	____	39. E:	____________________
30. resistor	____	40. k:	____________________

SCORE:

GRADE:

Name: ____________________

Date: ____________________

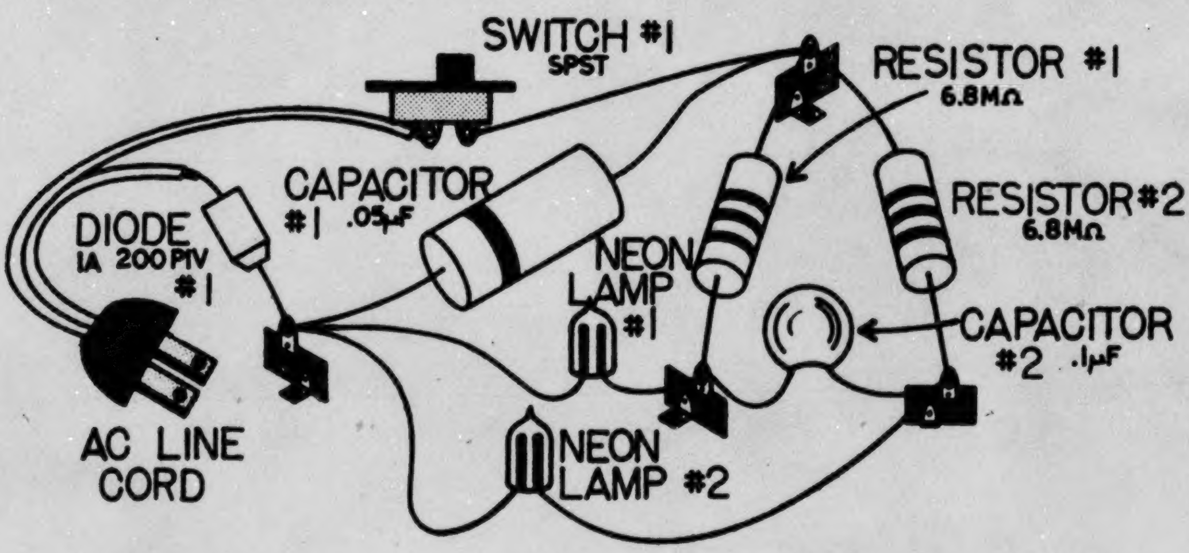
Period: ____________________

WORKSHEET

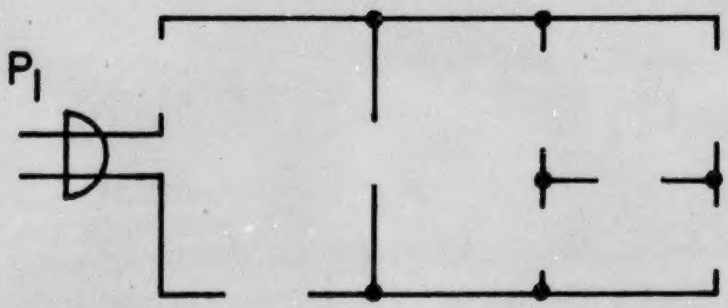
QUEST ACTIVITY

"UNIT 10"

Below you will find a pictorial diagram of a "blinking lamp - night light" circuit. As you can see, the pictorial diagram is rather large and congested. Each part is drawn as it physically appears, along with necessary descriptive information. A schematic diagram can also be used to represent the same circuit. The schematic diagram will utilize symbols to represent the various components, and letter designations to identify-parts and provide information. Your task is to study the pictorial diagram and then complete the schematic diagram by drawing in the correct symbols in their proper locations. You are also to include letter designations and electrical units on your schematic.


SWITCH #1
SPST
RESISTOR #1
6.8MΩ
CAPACITOR
#1 .05µF
DIODE
1A 200PIV
#1
NEON
LAMP
#1
RESISTOR#2
6.8MΩ
CAPACITOR
#2 .1µF
AC LINE
CORD
NEON
LAMP #2

PICTORIAL



SCHEMATIC

Name: ____________________

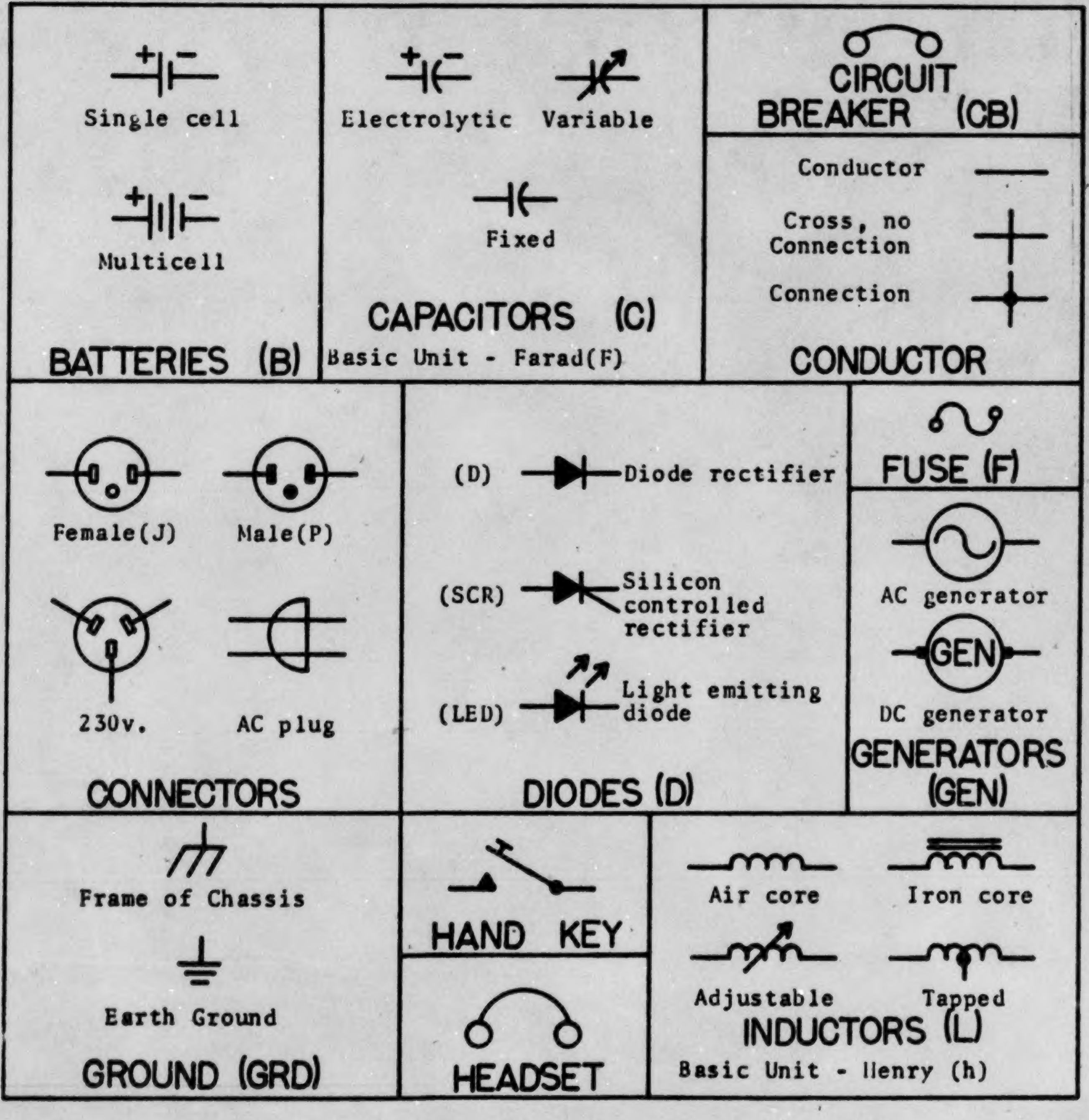
Date: ____________________

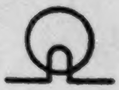
Period: ____________________

INFORMATIONAL HANDOUT

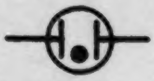
SCHEMATIC SYMBOLS

Illustrated below is a list of schematic symbols commonly used to depict electrical and electronic devices. Currently accepted letter designations and unit abbreviations are also provided.


Single cell
Multicell
BATTERIES (B)
Electrolytic
Variable
Fixed
CAPACITORS (C)
Basic Unit - Farad(F)
CIRCUIT BREAKER (CB)
Conductor
Cross, no Connection
Connection
CONDUCTOR
Female(J)
Male(P)
230v.
AC plug
CONNECTORS
(D)
Diode rectifier
(SCR)
Silicon controlled rectifier
(LED)
Light emitting diode
DIODES (D)
FUSE (F)
AC generator
GEN
DC generator
GENERATORS (GEN)
Frame of Chassis
Earth Ground
GROUND (GRD)
HAND KEY
HEADSET
Air core
Iron core
Adjustable
Tapped
INDUCTORS (L)
Basic Unit - Henry (h)

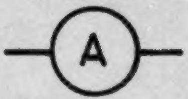


Incandescent lamp

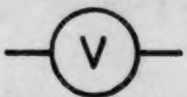


Neon lamp

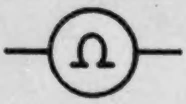
LAMPS (LP)



Ammeter

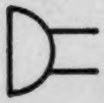


Voltmeter

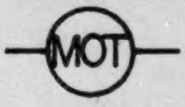


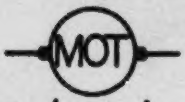
Ohmmeter

METERS (M)



MICROPHONE

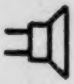
AC motor 

DC motor 

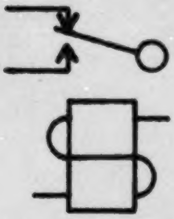
MOTORS (MOT)

+	−
Positive	Negative

POLARITY

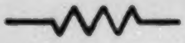


SPEAKER (SPKR)

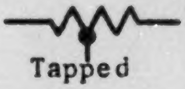


Single pole, double throw

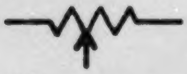
RELAY (K)



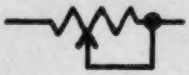
Fixed



Tapped



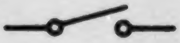
Adjustable

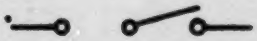


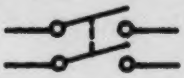
Rheostat

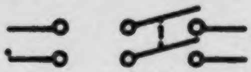
RESISTORS (R)

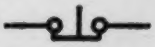
Basic Unit - Ohm(Ω)

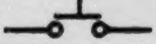
Single pole, single throw (SPST).... 

Single pole, double throw (SPDT)... 

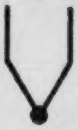
Double pole, single throw (DPST).... 

Double pole, double throw (DPDT)... 

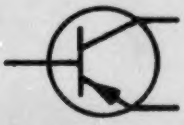
Pushbutton, normally closed (PBNC)........... 

Pushbutton, normally open (PBNO)............. 

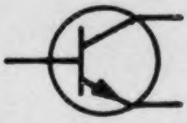
SWITCHES (S)



THERMOCOUPLE (TC)

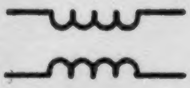


PNP

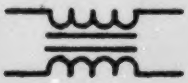


NPN

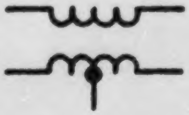
TRANSISTORS (Q)



Air core



Iron core



Tapped

TRANSFORMERS (T)

The following abbreviations are standards adopted by the Institute of Electrical and Electronic Engineers (IEEE).

TERM	
alternating current	AC
ampere or amp	A
capacitance	C
current	I
cycles per second	cps
direct current	DC
electromotive force	EMF
farad	F
ground	GND
henry	h
hertz	Hz
inductance	L
input	IN
kilo	k
kilowatt-hour	kwh
mega	M
micro	μ
micro-micro	μμ
milli	m
nano	n
negative	-
ohm	Ω
output	OUT
pico	p
positive	+
power	P
resistance	R
second	s
sine wave	∼
volt	V
voltage	E
watt	W

SCORE:

GRADE:

Name: ____________________

Date: ____________________

Period: ____________________

ANSWER SHEET

EXAM LII U10

	T A	F B	C	D		T A	F B	C	D		T A	F B	C	D		T A	F B	C	D
1.	■				26.					51.					76.				
2.	■				27.					52.					77.				
3.	■				28.					53.					78.				
4.		■			29.					54.					79.				
5.		■			30.					55.					80.				
6.	battery				31.					56.					81.				
7.	lamp				32.					57.					82.				
8.	motor (DC)				33.					58.					83.				
9.	resistor				34.					59.					84.				
10.	SPST switch				35.					60.					85.				
11.	plug (AC)				36.					61.					86.				
12.	transistor (NPN)				37.					62.					87.				
13.	capacitor				38.					63.					88.				
14.	ohm				39.					64.					89.				
15.	transformer				40.					65.					90.				
16.	direct current				41.					66.					91.				
17.	inductor				42.					67.					92.				
18.	transistor				43.					68.					93.				
19.	diode				44.					69.					94.				
20.	ground				45.					70.					95.				
21.					46.					71.					96.				
22.					47.					72.					97.				
23.					48.					73.					98.				
24.					49.					74.					99.				
25.					50.					75.					100.				

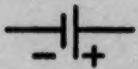
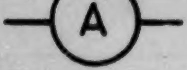
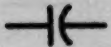
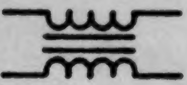
*Show work for problems on back of answer sheet.

ANSWER KEY
UNIT 10

A. WORD DECODING

1. term
2. symbol
3. component
4. connection
5. subscripts
6. abbreviation
7. numerical value
8. schematic diagram
9. letter identification
10. reference designation
30. R
31. inductor
32. direct current
33. double pole double throw
34. transistor
35. diode
36. lamp
37. transformer
38. ampere
39. voltage
40. kilo

B. ELECTRICAL TERMS AND SYMBOLS

1.

2.

3.

4.

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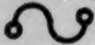
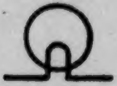
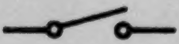
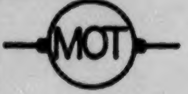
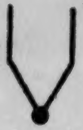
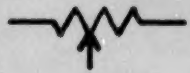

6.

7.

8.

9.

10.


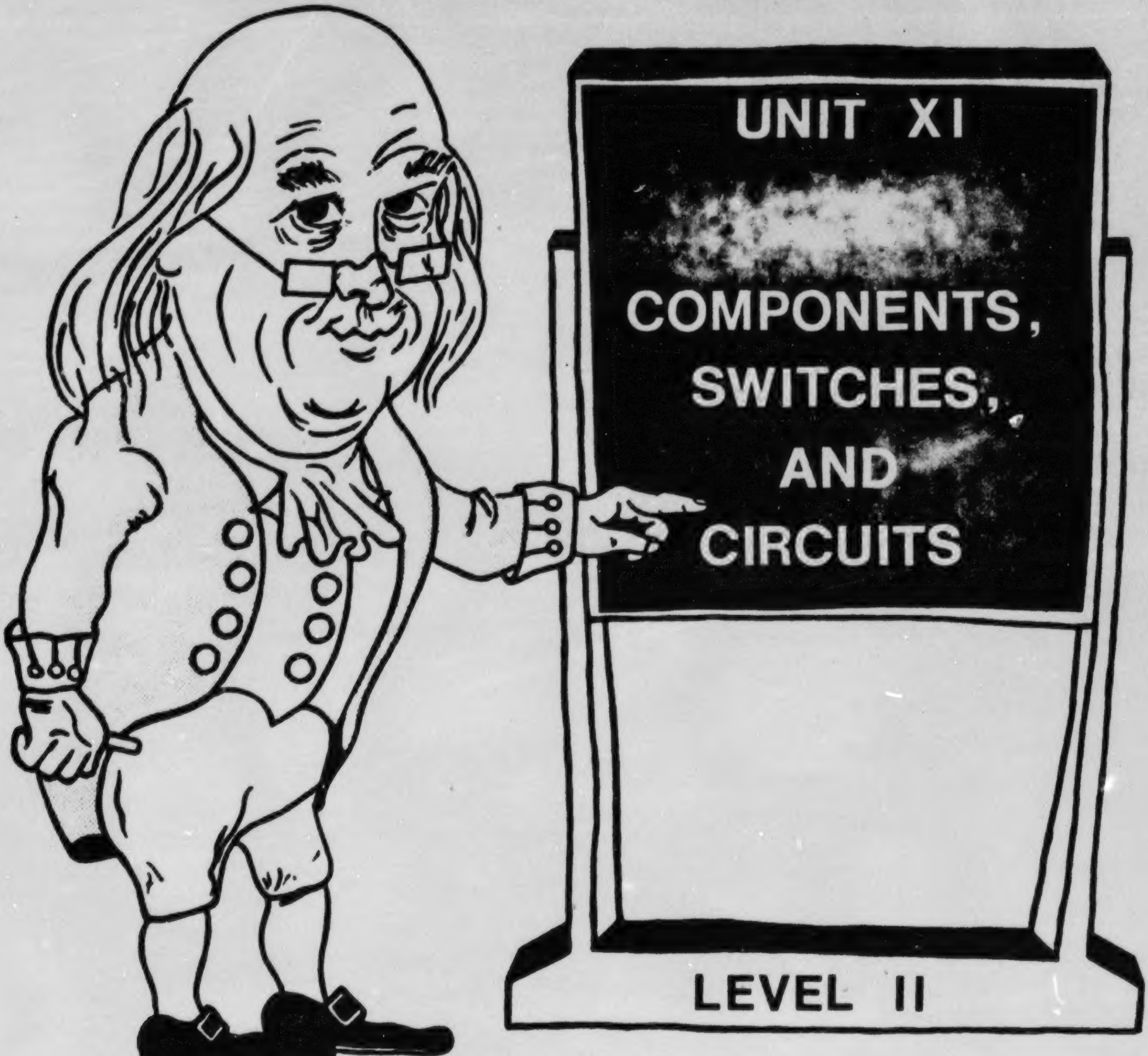
11. diode
12. connection
13. transistor (NPN)
14. push button switch N.O.
15. fixed resistor
16. voltmeter
17. AC plug
18. speaker
19. battery
20. AC generator
21. I
22. GRD
23. m
24. Ω
25. +
26. C
27. B
28. S
29. LED

C. QUEST ACTIVITY

(subjective evaluation)

ELECTRICITY / ELECTRONICS

CURRICULUM GUIDE
INSTRUCTIONAL MODULE



UNIT XI

COMPONENTS, SWITCHES, AND CIRCUITS

LEVEL II

STATE OF CALIFORNIA
DEPARTMENT OF EDUCATION

NAME____________________
DATE STARTED__________
DATE COMPLETED_______

BY
R. E. LILLO
N. S. SOFFIOTTO

STATE ELECTRICITY/ELECTRONICS CURRICULUM GUIDE
INSTRUCTOR'S GUIDE TO ACCOMPANY LEVEL II UNIT #11

Title of Unit: Components, Switches, and Circuits

Time Allocation: 2 weeks

Unit Goal:

To stimulate and instill student competence in basic component and circuit identification, including knowledge related to switches, types of circuit configurations, and recognition of simple circuit malfunctions.

Unit Objectives:

The student will be able to:

1. identify and explain the general technical function of the following common components: resistor, inductor, capacitor, switch, speaker, xenon flashtube, neon lamp, transformer, and diode.
2. demonstrate basic circuit construction skills by physically manipulating electrical devices into either series, parallel, or combination circuit configurations.
3. perform basic inspection and troubleshooting steps in order to locate a defective or abnormal circuit condition.

Evaluation:

The student will demonstrate his/her competence in terms of these measurable objectives based upon individual instructors acceptable performance criteria, which may utilize a combination of written, oral, and laboratory testing procedures.

Instructor References:

Basic Electricity Training Manual. Ted Pipe, Howard W. Sams and Co., 1976. Chapters: 1, 2, 3, and 5.

Electronics Assembly and Fabrication Methods. S.R. Duarte and R.L. Duarte, McGraw-Hill Book Co., 1973. Chapters: 2, 4, 11, and 12.

Technical Electricity and Electronics. Peter Buban and Marshall L. Schmitt, McGraw-Hill Book Co., 1977. Units: 6, 7, 8, 15, 16, 20, 26, and 28.

Overview:

Unit 11 was designed with the intent of providing sufficient technical knowledge for the student so that successful kit or project construction could be an immediate reality.

The first unit topic presented should be oriented towards teaching component identification, with specific emphasis on those common components encountered in typical beginning type projects or kits.

Next, circuit controlling devices are discussed because this topic is directly applicable to many aspects of both project and/or laboratory circuit operation, yet, most instructors seldom take time to allow students to really examine switches.

An explanation of simple circuit configurations has been included as a means to discuss and discover the electrical characteristics of various kinds of circuits, and the study of basic circuits will help formulate in the student's mind a technical reference point of what constitutes normal circuit behavior.

Suggested Presentation Hints/Methodology:

Follow the instructional module unit outline as a basic skeleton for curriculum presentation, however, note the following:

1. Investigate with the class a variety of components that they might typically encounter when building a simple project. Use an overhead projector and place a component on top of the stage plate and examine its size and shape, then, discuss the general purpose, special properties, value determination/codes, and other essential data.
2. Stress during a presentation that many types of switches are used to control electricity and each variety has unique characteristics which may offer certain advantages or disadvantages. Try to collect and display switches of different physical conformation and function, then explain that in its simplistic form a switch is still merely a device to open or close a circuit. It may be helpful to concentrate on the specific symbol when describing a certain type of switch, because exposure to the symbol allows the student an opportunity to examine the way in which the switch operates in the circuit.
3. It may be time consuming, but important to the class to review the essential parts of a circuit. Once this has been rediscovered and the students feel comfortable with the theory, slip into a discussion on devices in series and parallel. The relationship of "E" and "I" for these networks are the important concepts to establish as a solid technical foundation.

Supplemental Activities and Demonstrations:

1. Training systems and paperwork sometimes miss the point in respect to switches and the method of connecting them to control a circuit. Perhaps this and the idea of connecting devices in series and parallel should be explored further in a laboratory type performance test. Buzzers and switches mounted on a board with terminals exposed can serve as an excellent evaluator when students are asked to systematically create basic circuit configurations. After each circuit has been built, sign the student off and let them go on to a more complex configuration.
2. Develop several experiments to illustrate various abnormal circuit conditions. Control the demonstration, but if a componen or two were to burn up in front of their eyes the impact is much greater! Try to direct students to use a detective style approac to solving problem circuits. Observe symptoms, look for the clues logically deduce malfunction, then repair and check.

Instructional Module Contents:

1. Unit Outline (overhead)
2. Pre-Post Test (keyed)
3. Technical Glossary
4. Worksheet (vocabulary) - Spelling Puzzle
5. Worksheet - Component Identification
6. Quest Activity
7. Informational Handout (Basic Electronic Components Used in Project Construction)
8. Informational Handout (Normal and Abnormal Circuits)
9. Unit Module Answer Keys

XI. Components, Switches, and Circuits

A. Common Component Identification
   1. Physical characteristics

   2. Value determination or identification codes

   3. Purpose and/or usage

B. Circuit Controlling Devices
   1. Switches used as control devices

   2. Types of switches

   3. Switch circuits

C. Basic Electrical Circuits
   1. Series circuits

   2. Parallel circuits

   3. Series parallel circuitry

D. Connecting Switches in Series and Parallel

   1. Series switching circuits

2. Parallel switching circuits

E. Normal and Abnormal Circuits
   1. Closed circuit

   2. Open circuit

   3. Shorted circuit

Test Number _____

LII-U11

UNIT EXAM

COMPONENTS, SWITCHES, AND CIRCUITS

IMPORTANT-

Indicate your responses on the answer sheet only. Fill in the box corresponding to the correct answer to each question - there is only one correct answer for each question.

1. Resistor values are given in ohms. (T-F)

2. A potentiometer is a variable resistor which contains three terminals, and has a movable center shaft. (T-F)

3. A transistor has the ability to step-up or step-down voltage. (T-F)

4. Abnormal circuits commonly contain either a short or an open condition (T-F)

5. Capacitors will allow current to flow in only one direction through a circuit. (T-F)

6. An open circuit provides an easy path for current flow. (T-F)

7. A switch is used to either open or close a circuit, or to direct current flow through the circuit. (T-F)

8. A parallel circuit contains only one path for current flow. (T-F)

9. Capacitors are rated in units of micro or pico farads. (T-F)

10. Switches are always connected in series with the current path they are controlling. (T-F)

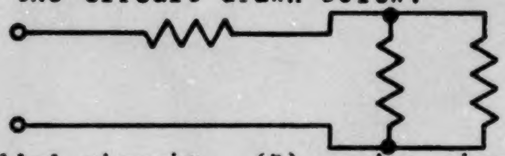
11. The abbreviation "P.B.N.O." means:
(A) pull back, now open, (B) push button normally open, (C) push button not open, (D) push back naturally open.

12. An accidental circuit connection which causes excessive current, and possible circuit damage is called a/n:
(A) open, (B) branch, (C) short, (C) close.

13. A circuit which contains more than one path for current flow is known as a/n:
(A) parallel circuit, (B) series circuit, (C) abnormal circuit, (D) normal circuit.

14. Identify the switch which is capable of controlling two separate circuits simultaneously.
(A) SPST, (B) PBNO, (C) DPNT, (D) DPST.

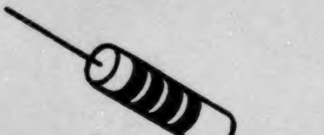
15. Classify the circuit drawn below:



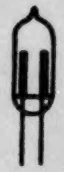
(A) parallel circuit, (B) series circuit, (C) compound circuit, (D) series-parallel circuit.

Identify the component drawings below:

16.



17.



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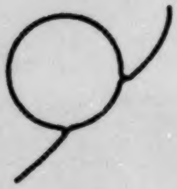

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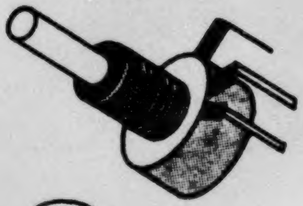

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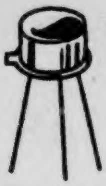


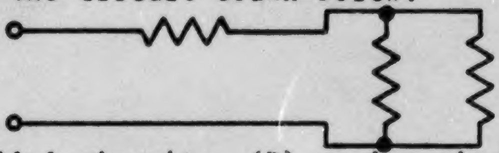
11. The abbreviation "P.B.N.O." means:
(A) pull back, now open, (B) push button normally open, (C) push button not open, (D) push back naturally open.

12. An accidental circuit connection which causes excessive current, and possible circuit damage is called a/n:
(A) open, (B) branch, (C) short, (C) close.

13. A circuit which contains more than one path for current flow is known as a/n:
(A) parallel circuit, (B) series circuit, (C) abnormal circuit, (D) normal circuit.

14. Identify the switch which is capable of controlling two separate circuits simultaneously.
(A) SPST, (B) PBNO, (C) DPNT, (D) DPST.

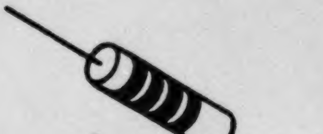
15. Classify the circuit drawn below:



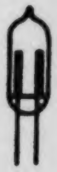
(A) parallel circuit, (B) series circuit, (C) compound circuit, (D) series-parallel circuit.

Identify the component drawings below:

16.



17.



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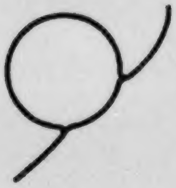

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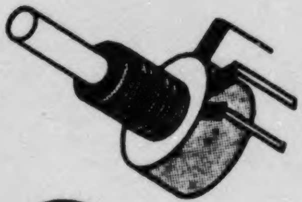

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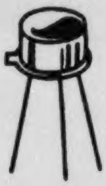
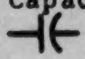
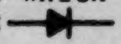
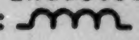
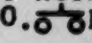
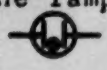
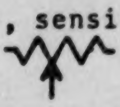
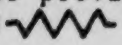


Name: ____________________

Date: ____________________

Period: ____________________

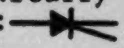
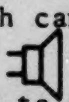
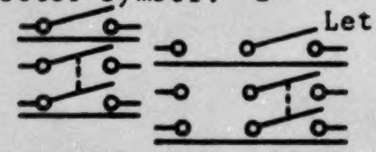
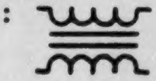
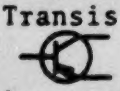
TECHNICAL GLOSSARY

ABNORMAL CIRCUIT:	A circuit which is not functioning properly. An abnormal circuit is generally open (a broken current path) or shorted (an undesired current path).
CAPACITOR:	An electronic component made up of two metal plates separated by an insulator. Capacitors have the ability to store a charge. Symbol:  Letter symbol: C
CLOSED CIRCUIT:	Any electrical circuit which contains a complete path for current flow from the negative terminal of the source to the positive terminal.
DIODE:	A semiconductor device which acts as a one way valve to current flow. Symbol:  Letter symbol: D
INDUCTOR:	An electronic component made by wrapping a coil of wire around an air or iron core. An inductor opposes any change in current flow. Symbol:  Letter symbol: L
MOMENTARY SWITCH:	A type of switch which is operated by pushing on a lever or button. Once the pressure is removed, the switch is "turned off." Momentary-contact switches are often push-button type switches, and are available as either normally open or normally closed devices. Symbol: P.B.N.C. P.B.N.O.  Letter symbol: S
NEON LAMP:	A glow lamp which contains neon gas. When a voltage of approximately 55 volts is applied to the lamp, the neon gas ionizes and glows orange. Symbol:  Letter symbol: LP
NORMAL CIRCUIT:	A circuit which is functioning properly, and provides a complete path for current flow.
OPEN CIRCUIT:	A circuit which contains a break or gap in the current path. The "break" will stop the circuit from operating.
PARALLEL CIRCUIT:	A circuit which contains two or more paths for current flow, sometimes referred to as a shunt or branch circuit.
POTENTIOMETER:	A variable resistor commonly used as volume, sensitivity, or speed control on many projects. Symbol:  Letter symbol: R
RESISTOR:	A simple, yet important, electronic component made from either carbon, wire, or metal oxide, and used to provide a specific opposition to current flow. Symbol:  Letter symbol: R

Name: ____________________

Date: ____________________

Period: ____________________

SERIES CIRCUIT:	A circuit which allows only one path for current flow. Components connected in series are joined in a line, one after the other.
SERIES PARALLEL CIRCUIT:	A circuit consisting of one or more series and parallel paths. Series-parallel circuits are often called combination circuits.
SHORTED CIRCUIT:	A circuit which contains a low resistance path between two points (power supply terminals, line, etc.), which causes excessively high current flow and possible circuit damage. A shorted circuit is usually caused by an accidental connection.
SILICON CONTROLLED RECTIFIER:	A three terminal electronic component belonging to the "diode family," and having the ability to electronically switch on and off, fairly large currents. Symbol:  Letter abbrev.: SCR
SLIDE SWITCH:	A style of switch in which a bar of metal is made to move or slide, making contact between two points--either opening or closing the circuit. Slide switches are generally low in cost.
SPEAKER:	An electronic component which can convert electrical signals into sound. Symbol:  Letter symbol: SPKR
SWITCH:	An electronic component used to control or direct current flow. Most commonly, switches are used to open or close a circuit path. Switches are available in many styles and configurations, such as push-button, slide, toggle, micro, rotary, single pole single throw, double pole single throw, single pole double throw, double pole double throw, etc. Letter symbol: S Symbol:  Letter abbrev. SPST SPDT DPST DPDT
TOGGLE SWITCH:	A common switch style which uses a "snap action" principle to move a set of contacts from one side of the switch to the other, opening or closing the circuit.
TRANSFORMER:	An electronic component able to either step-up (increase) or step-down (decrease) an AC voltage. Symbol:  Letter symbol: T
TRANSISTOR:	An electronic component which can be used to amplify an electric signal. Transistors are also used as high speed switches. Symbol:  Letter symbol: Q
XENON FLASHTUBE:	A special purpose lamp, capable of producing a brilliant flash of light. Xenon flashtubes are found in strobe lights and photographic strobes.

SCORE:

GRADE:

Name: ____________________

Date: ____________________

Period: ____________________

WORKSHEET

VOCABULARY - SPELLING PUZZLE

Copy the correctly spelled word in the box at the right. As indicated in the example below.

A.	(ampmeter)	(ammeter)	(ameter)	A.	ammeter
1.	(curcuit)	(sircuit)	(circuit)	1.	
2.	(diode)	(dyode)	(diold)	2.	
3.	(siries)	(ceries)	(series)	3.	
4.	(tagole)	(toggle)	(toggel)	4.	
5.	(speaker)	(speeker)	(speker)	5.	
6.	(switch)	(swich)	(swit)	6.	
7.	(parelel)	(parallel)	(parrallel)	7.	
8.	(silicon)	(silecon)	(silacon)	8.	
9.	(capasetor)	(capaciter)	(capacitor)	9.	
10.	(normel)	(normol)	(normal)	10.	
11.	(inducter)	(inductor)	(enductor)	11.	
12.	(momentary)	(monantary)	(momintary)	12.	
13.	(tramsister)	(transister)	(transistor)	13.	
14.	(rectifire)	(rectifier)	(recktifier)	14.	
15.	(potenteometer)	(potentimeter)	(potentiometer)	15.	

SCORE:	
GRADE:	

Name: ____________________

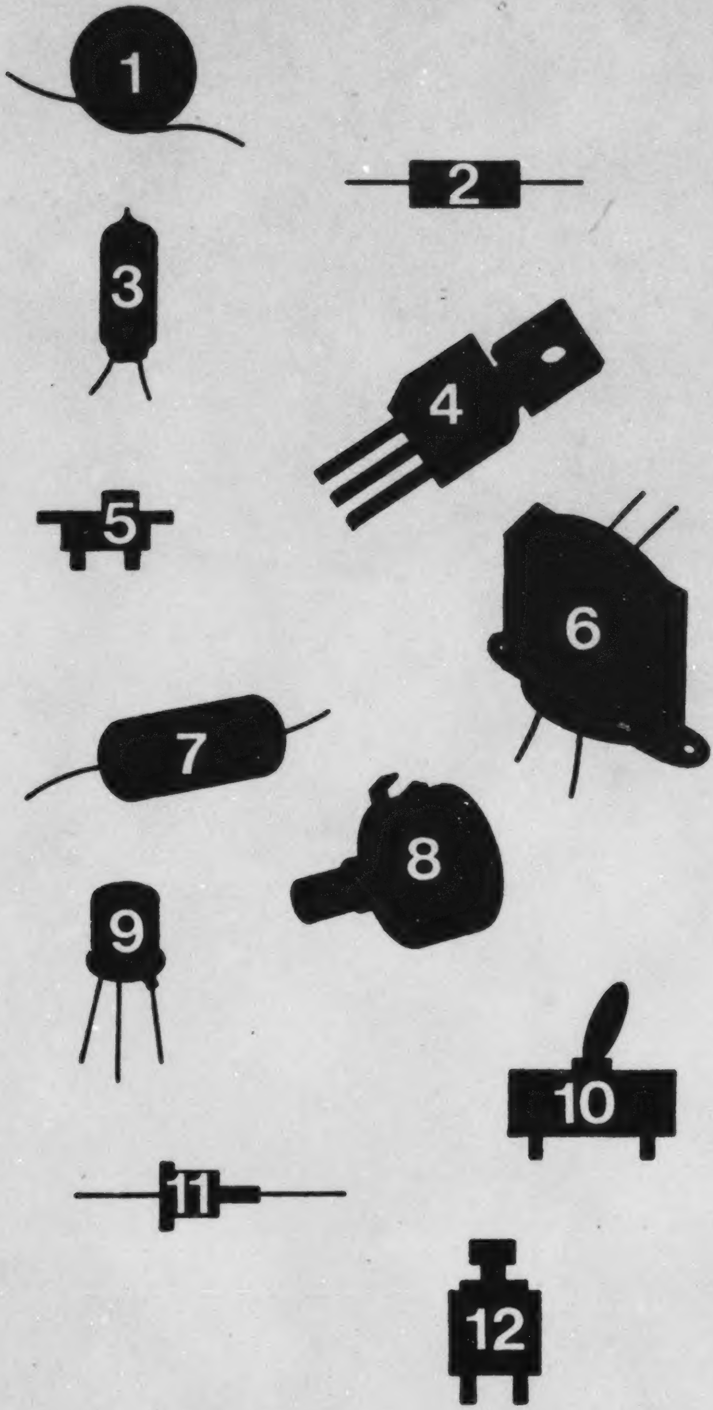
Date: ____________________

Period: ____________________

WORKSHEET

COMPONENT IDENTIFICATION

Identify the component drawings shown below.


1
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12

1.		1.	
2.		2.	
3.		3.	
4.		4.	
5.		5.	
6.		6.	
7.		7.	
8.		8.	
9.		9.	
10.		10.	
11.		11.	
12.		12.	

SCORE:

GRADE:

Name: ____________________

Date: ____________________

Period: ____________________

WORKSHEET

QUEST ACTIVITY

"UNIT 11"

Use the component puppets provided on page three to construct the circuits described below. You will cut out and arrange the puppets to form series, parallel, and series-parallel circuits. You must draw in interconnecting lines to represent conductors. Be sure that each problem fulfills the four requirements for a complete electric circuit - i.e. supply, control, load, and conductor.

1. Construct a series circuit, utilizing a 1.5 volt cell to supply power, a SPST switch to control current flow, and two lamps as load devices.

2. Design a parallel circuit, using a 110V source, and a SPST switch as an on-off control. The circuit is to contain three branches, each branch will operate a different load device.

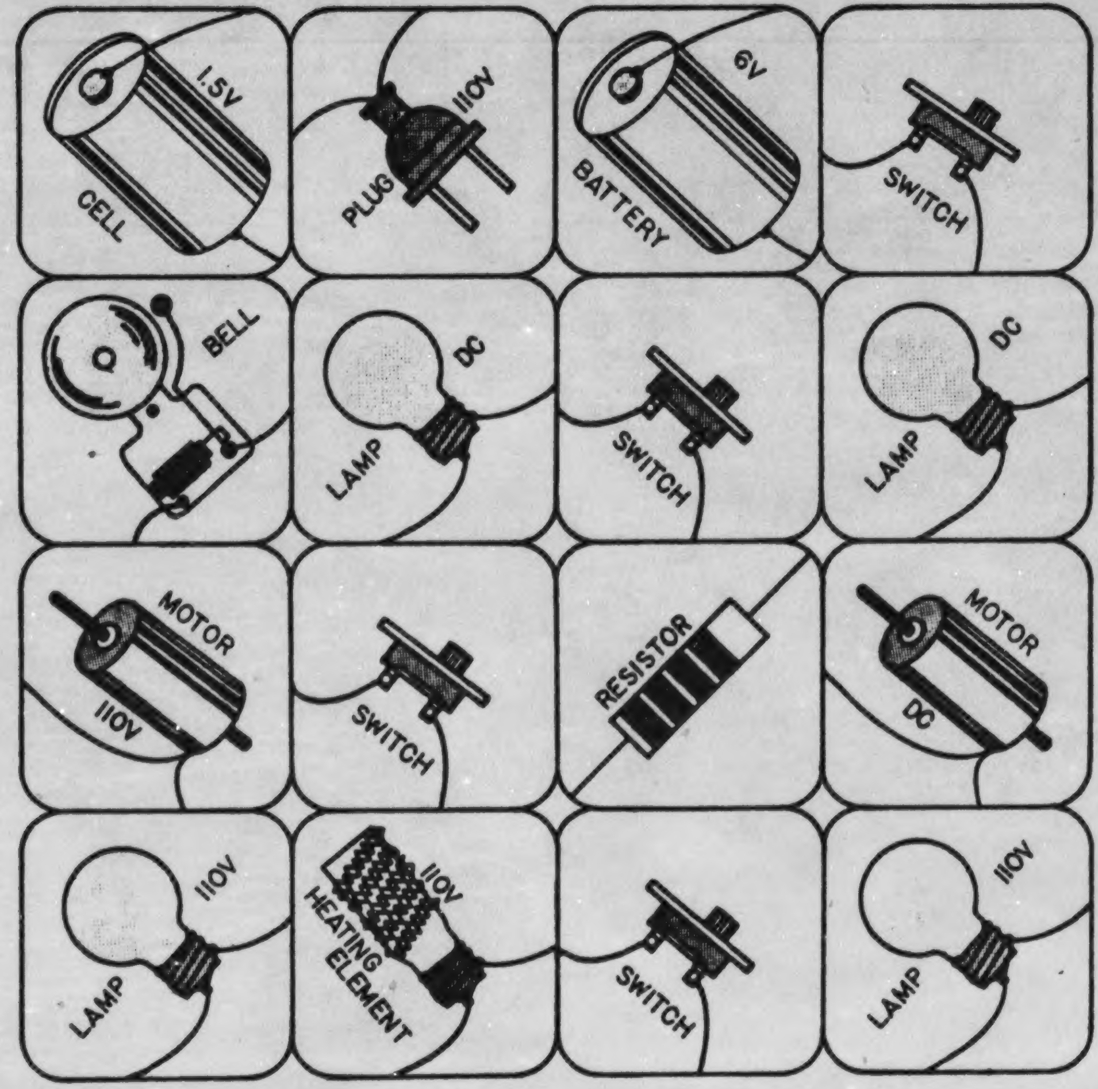
Name: ____________________

Date: ____________________

Period: ____________________

3. Assemble a series-parallel circuit consisting of two series loads, and two parallel loads. The circuit operates on 6V DC, contains a SPST switch which will de-energize the total circuit, and a SPST switch to control one of the parallel loads. You may utilize any four appropriate load devices.

Component Puppets


1.5V
CELL
110V
PLUG
6V
BATTERY
SWITCH
BELL
DC
LAMP
SWITCH
DC
LAMP
MOTOR
110V
SWITCH
RESISTOR
MOTOR
DC
110V
LAMP
110V
HEATING ELEMENT
SWITCH
110V
LAMP

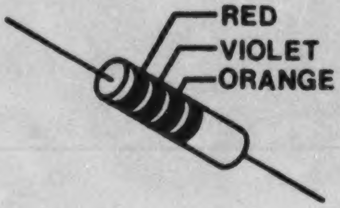
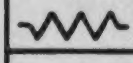
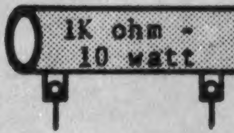
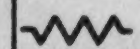
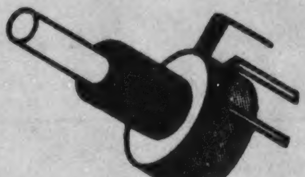
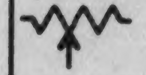
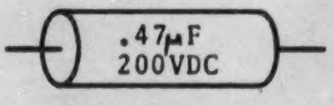
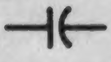
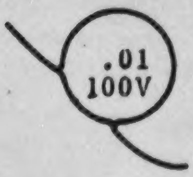
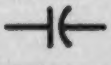
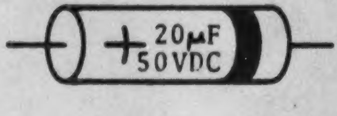
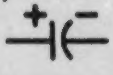
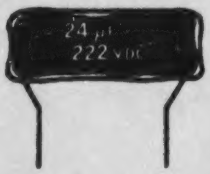
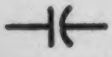
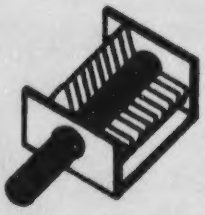
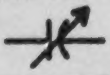
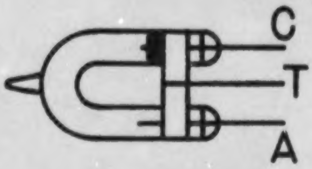
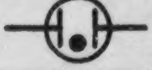
Name: ______________________

Date: ______________________

Period: ______________________

INFORMATIONAL HANDOUT

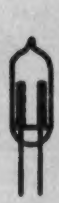
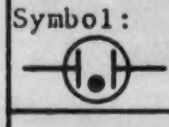
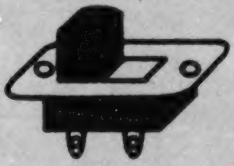
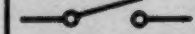
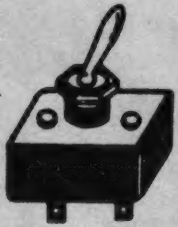
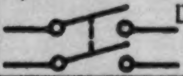
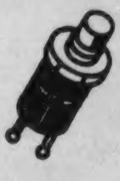
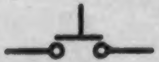
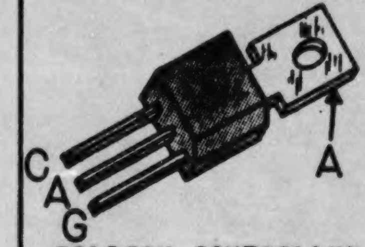
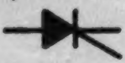
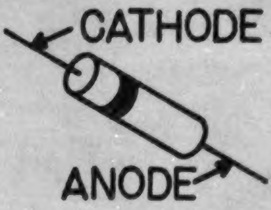
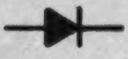
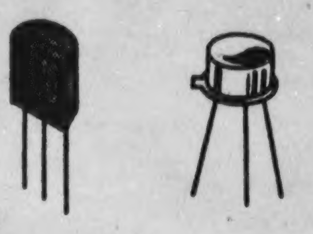
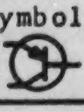
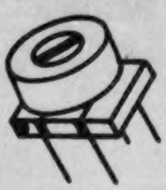
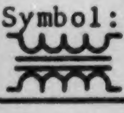
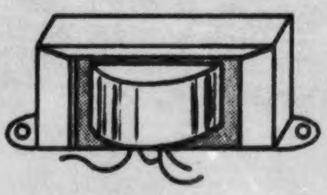
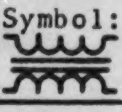
BASIC ELECTRONIC COMPONENTS USED IN PROJECT CONSTRUCTION

 RED VIOLET ORANGE CARBON COMPOSITION RESISTOR Symbol:  Letter Designation: R	 1K ohm - 10 watt POWER RESISTOR Symbol:  Letter Designation: R	 POTENTIOMETER Symbol:  Letter Designation: R
 .47μF 200VDC TUBULAR CAPACITOR Symbol:  Letter Designation: C	 CERAMIC OR DISC CAPACITOR Symbol:  Letter Designation: C	 ELECTROLYTIC CAPACITOR Symbol:  Letter Designation: C
 24 μF 222 VDC MYLAR CAPACITOR Symbol:  Letter Designation: C	 VARIABLE CAPACITOR Symbol:  Letter Designation: C	 XENON FLASHTUBE Symbol:  Letter Designation: LP

Name: ____________________

Date: ____________________

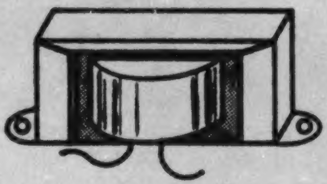
Period: ____________________

 **NEON LAMP** Symbol:  Letter Designation: LP	 **SPST SLIDE SWITCH** Symbol:  Letter Designation: S	 **DPST TOGGLE SWITCH** Symbol:  Letter Designation: S
 **N.O. PUSH-BUTTON SWITCH** Symbol:  Letter Designation: S	 **SILICON CONTROLLED RECTIFIER** Symbol:  Letter Designation: SCR	 **SEMICONDUCTOR DIODE** Symbol:  Letter Designation: D
 **TRANSISTOR** Symbol:  Letter Designation: Q	 **TRIGGER TRANSFORMER** Symbol:  Letter Designation: T	 **TRANSFORMER** Symbol:  Letter Designation: T

Name: ____________________

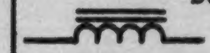
Date: ____________________

Period: ____________________

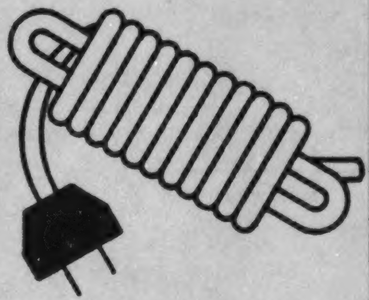


INDUCTOR (COIL)

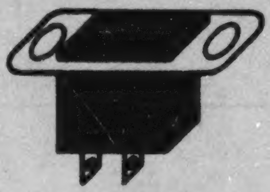
Symbol:



Letter Designation: L



AC LINE CORD



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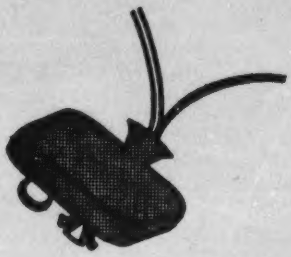

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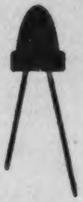
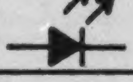


LIGHT EMITTING DIODE

Symbol:



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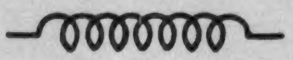
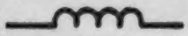


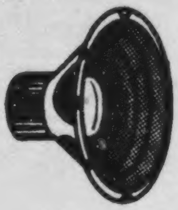
INDUCTOR (COIL)

air core

Symbol:

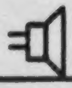


Letter Designation: L



SPEAKER

Symbol



Letter Designation: SPKR

Name: ____________________

Date: ____________________

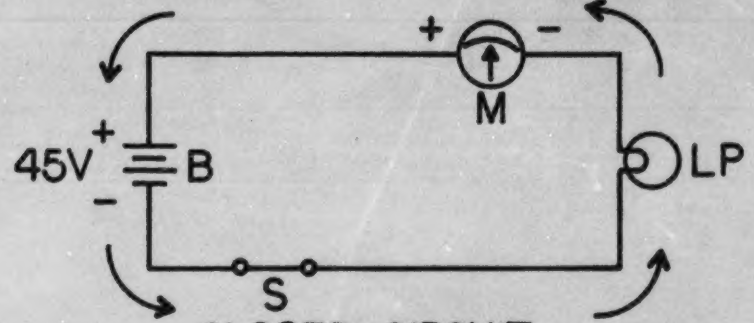
Period: ____________________

INFORMATIONAL HANDOUT

NORMAL AND ABNORMAL CIRCUITS

The schematic below shows a typical circuit in which a DC voltage, "E", forces the current, "I", through a load device. This is called a closed circuit because all of the circuit parts are connected in a manner which allows an unbroken path for the flow of electrons. The load device (lamp) will operate properly and the circuit is considered normal in terms of operation.

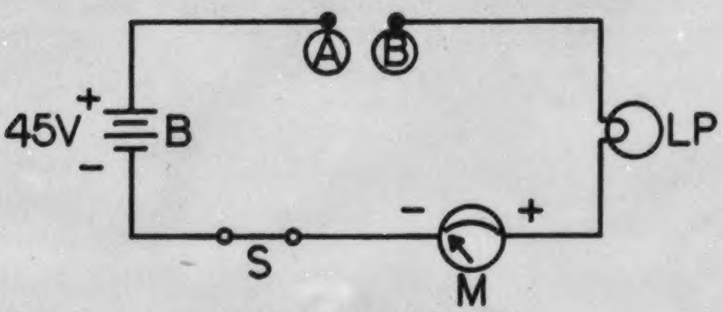
normal = closed



CLOSED CIRCUIT

The next circuit has been broken open between points A and B, hence, the term open circuit. Since electrons cannot jump the gap from A to B, no current can flow from the battery to the load device, thus the circuit is considered disabled. Closing a circuit usually means turning it on or placing it in operation; while opening a circuit means generally the act of turning a circuit off or that the circuit is nonfunctioning due to an abnormal circuit condition. Many times an open circuit has been created by a wire or component breaking in half and stopping the current flow.

abnormal = open



OPEN CIRCUIT

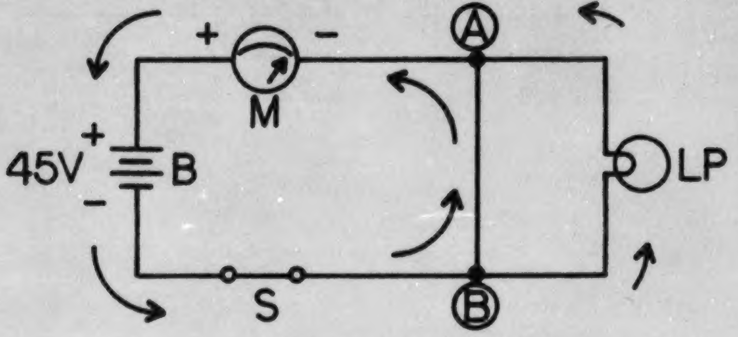
Name: ____________________

Date: ____________________

Period: ____________________

The last schematic indicates that a conductor has been accidently connected across the circuit from "A" to "B". Because of the lower resistance of the path between "A" and "B" most of the current (I) flows through this path, robbing the load device of its proper current flow. This condition often is spoken of by technical people as "electricity taking the path of the least resistance." We should know that most, not all, of the current flows through this abnormal path, however, because of the shorter route taken by the current in this case, path "A" to "B", this abnormal circuit is called a short circuit. Generally, short circuits are unintentional, being caused either by accident or by mistakes in wiring. A wire or piece of metal falling onto an electrical circuit can cause a short circuit. Short circuits must be avoided since they can cause damage to power sources and circuit components because of the large currents they create. A portion of a circuit as well as the whole circuit may become short-circuited, and in either case short circuits are ....DANGEROUS!!!!!!!!!

abnormal = shorted



SHORT CIRCUIT

REVIEW

A typical normal circuit is one which operates properly and usually contains the following:

1. A source of "E" and "I" ..... Supply.
2. A device to turn the circuit on or off .....Control.
3. A path for electricity to travel through ..... Conductor.
4. A device to operate ..... Load.

When a circuit does not operate right, it is said to be abnormal. There are two main types of defective or abnormal circuits that must be frequently repaired.

1. Open circuits
2. Shorted circuits

As a repair person you might often be asked to fix electrical products. The process of determining whats wrong is called troubleshooting. To troubleshoot quickly requires that you study the characteristics of abnormal circuits.

SCORE:
GRADE:

Name: ________________

Date: ________________

Period: ________________

ANSWER SHEET

EXAM LII U11

	T	F				T	F				T	F				T	F		
	A	B	C	D		A	B	C	D		A	B	C	D		A	B	C	D
1.	■				26.					51.					76.				
2.	■				27.					52.					77.				
3.		■			28.					53.					78.				
4.	■				29.					54.					79.				
5.		■			30.					55.					80.				
6.		■			31.					56.					81.				
7.	■				32.					57.					82.				
8.		■			33.					58.					83.				
9.	■				34.					59.					84.				
10.	■				35.					60.					85.				
11.		■			36.					61.					86.				
12.			■		37.					62.					87.				
13.	■				38.					63.					88.				
14.				■	39.					64.					89.				
15.				■	40.					65.					90.				
16.	resistor				41.					66.					91.				
17.	neon lamp				42.					67.					92.				
18.	disc capacitor				43.					68.					93.				
19.	potentiometer				44.					69.					94.				
20.	transistor				45.					70.					95.				
21.					46.					71.					96.				
22.					47.					72.					97.				
23.					48.					73.					98.				
24.					49.					74.					99.				
25.					50.					75.					100.				

*Show work for problems on back of answer sheet.

ANSWER KEY
UNIT 11

A. SPELLING PUZZLE

1. circuit
2. diode
3. series
4. toggle
5. speaker
6. switch
7. parallel
8. silicon
9. capacitor
10. normal
11. inductor
12. momentary
13. transistor
14. rectifier
15. potentiometer

B. COMPONENT IDENTIFICATION

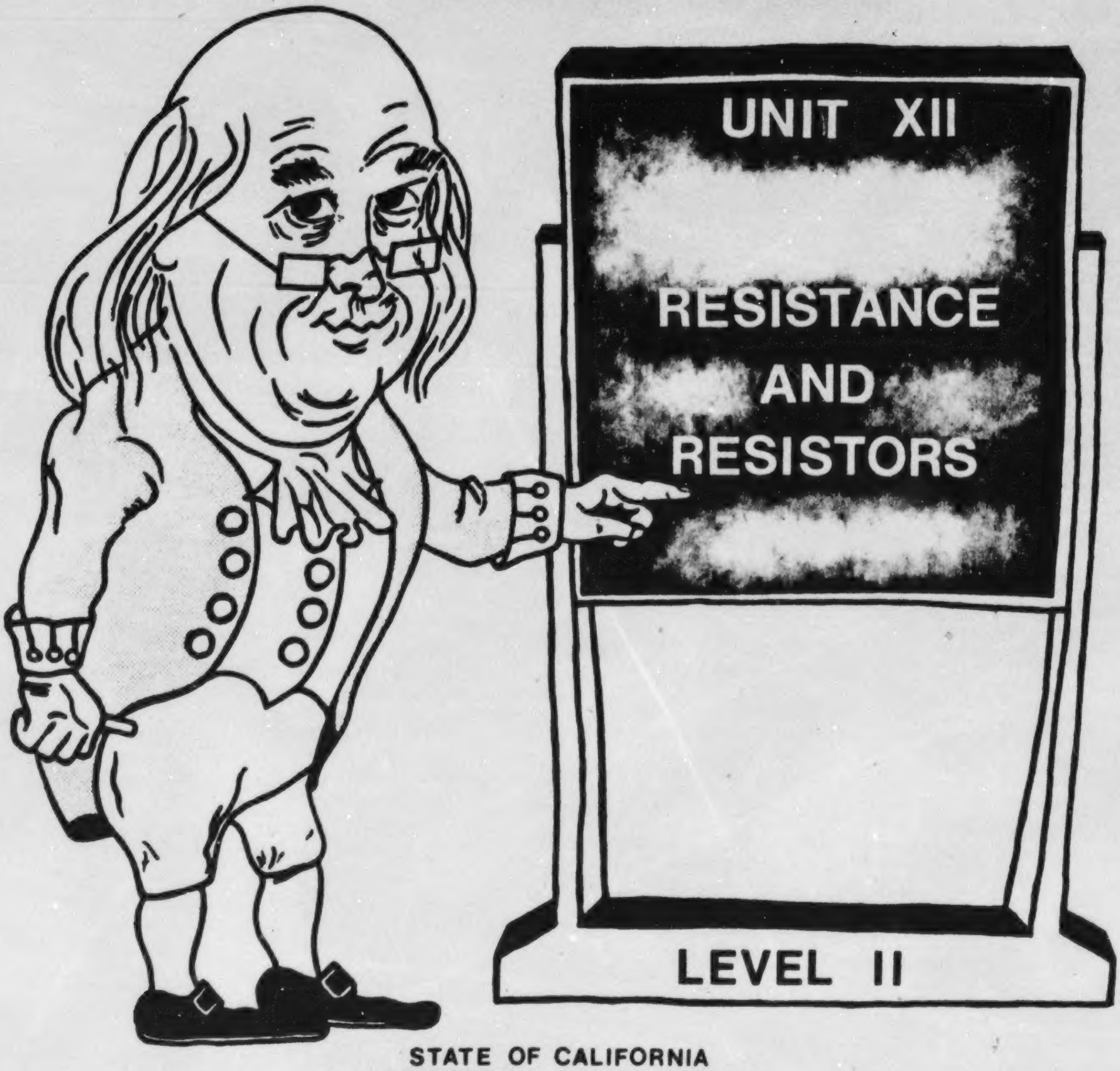
1. disc capacitor
2. carbon composition resistor
3. neon lamp
4. silicon controlled rectifier
5. slide switch
6. transformer
7. tubular capacitor
8. potentiometer or rheostat
9. transistor
10. SPST toggle switch
11. diode
12. push button switch

C. QUEST ACTIVITY

(subjective evaluation)

ELECTRICITY / ELECTRONICS

CURRICULUM GUIDE
INSTRUCTIONAL MODULE


UNIT XII
RESISTANCE
AND
RESISTORS
LEVEL II

STATE OF CALIFORNIA
DEPARTMENT OF EDUCATION

NAME____________________

DATE STARTED______________

DATE COMPLETED____________

BY
R. E. LILLO
N. S. SOFFIOTTO

STATE ELECTRICITY/ELECTRONICS CURRICULUM GUIDE
INSTRUCTOR'S GUIDE TO ACCOMPANY LEVEL II UNIT #12

Title of Unit: Resistance and Resistors

Time Allocation: 1 week

Unit Goal:

To divulge and develop those student competencies which will enable students to grasp the theory and application of resistance, and the nature and characteristics of resistive devices or components.

Unit Objectives:

The student will be able to:

1. define the term, symbol, and unit of measurement for resistance, and list the four factors which determine the resistance of wire.
2. name the three common types of resistors and the two coding systems utilized for indicating ohmic values.
3. identify the color coded value of any typical resistor, including the tolerance percentage and mathematically computing the usable tolerance range.

Evaluation:

The student will demonstrate his/her competence in terms of these measurable objectives based upon individual instructors acceptable performance criteria, which may utilize a combination of written, oral, and laboratory testing procedures.

Instructor References:

Electricity One-Seven. Harry Mileaf, Hayden Book Company, Inc., 1976. Chapter: Electricity Two.

Electronic and Electrical Fundamentals Volume I. Published by C.T.I. Education Products, Inc., 1976. Chapter: 4.

Individual Learning Program In DC Electronics. Heathkit Continuing Education, Heath Company, 1976. Unit: 3.

Overview:

Unit 12 has as its central goal the expansion of the student's technical competencies so that they will include the property of resistance.

Electrical resistance should be defined as the opposition to current flow, and the instructor should indicate also that all materials contain this quality. The thought that resistance might be a desired factor should be explored as well as the traditionally negative aspect of circuit resistance.

The next topic should be a discussion about wire conductors and the fact that one cannot even ignore devices that are designed to handle current, because they may have an appreciable amount of resistance.

The final topic of this unit expresses the idea that resistors were developed to provide high resistivity in a small package. Types of resistors along with coding systems, and the concepts of resistor value accuracy (tolerance) should be explored in a variety of appropriate exercises.

Suggested Presentation Hints/Methodology:

Follow the instructional module unit outline as a basic skeleton for curriculum presentation, however, note the following:

1. Traditionally, the topic of wire resistance usually precedes a discussion on resistive devices. This is still recommended, since it is easier for students to understand the need for a lumped amount of resistance in a circuit rather than yards and yards of cumbersome wire.
2. In this unit the concept or phrase types of resistors will refer to the resistor's internal composition (carbon, wire wound, or film) while the phrase resistor variety is alluding to the physical style (fixed, adjustable, or variable). When presenting this topic, display samples of the components that are available in the shop to help students become more familiar with their physical properties.
3. Prior to the class presentation on color code ask students to memorize the complete color code system. Select students individually to recite the colors and the number value.
4. The concept of resistor tolerance and the method of solving specific tolerance ranges are difficult for beginning students to comprehend. Walking the student through some simple problems wil improve their understanding and confidence. A review of basic mathematic skills such as percentage determination and decimals can especially assist slower students and is recommended.

Supplemental Activities and Demonstrations:

1. Make a demonstration display that includes a sample of resistors of various types, color code markings, and physical styles. Cement the parts on a board and label.
2. An informative visual aid can be quickly made by using an old cardboard container that has a cylinder shape. Insert a long welding rod through the container and plug the ends. This will act as the body of the resistor with pigtails, now paint the body with one solid color and add various color bands with color tape.
3. Using a flat piece of cardboard, in the shape of a carbon composition resistor, construct a resistor "mock up" with four see through pockets on one end. Insert different colored paper in each pocket to simulate a coded resistor, then hold the display up so that the class can view and discuss.

Instructional Module Contents:

1. Unit Outline (overhead)
2. Pre-Post Test (keyed)
3. Technical Glossary
4. Worksheet (vocabulary) - Know Your Definitions
5. Worksheet - Resistor Color Coding and Decoding
6. Quest Activities
7. Informational Handout (The Resistor Color Code)
8. Informational Handout (Resistors-What They Are And How They Function)
9. Unit Module Answer Keys

XII. Resistance and Resistors

A. Wire Resistance

B. Resistors
   1. Types of resistors

   2. Fixed and variable variety

C. Resistor Color Code
   1. Ohm's value

   2. Tolerance

Test Number _____

LII-U12

UNIT EXAM

RESISTANCE AND RESISTOR

IMPORTANT-

Indicate your responses on the answer sheet only. Fill in the box corresponding to the correct answer for each question - there is only one correct answer for each question.

1. A conductor is a material that provides a high resistance path for current flow. (T-F)

2. As a wire is made longer, its resistance will increase. (T-F)

3. Equal size pieces of gold wire and aluminum wire would have the same resistance. (T-F)

4. As the diameter or cross-sectional area of a wire decreases, its resistance also decreases. (T-F)

5. Changing the temperature of a conductor will not affect its overall resistance. (T-F)

6. Fixed resistors have the advantage that their resistance values can be easily adjusted by either rotating a shaft, or moving a slider. (T-F)

7. Potentiometers and rheostats are variable type resistors. (T-F)

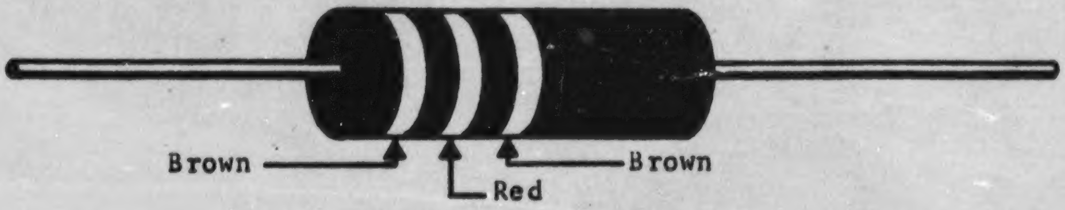
8. Wire wound resistors generally offer better accuracy and higher power ratings than carbon composition resistors. (T-F)

9. Carbon composition resistors have their resistance value clearly labeled on the body of the device. For example: "1000Ω±10% (T-F)

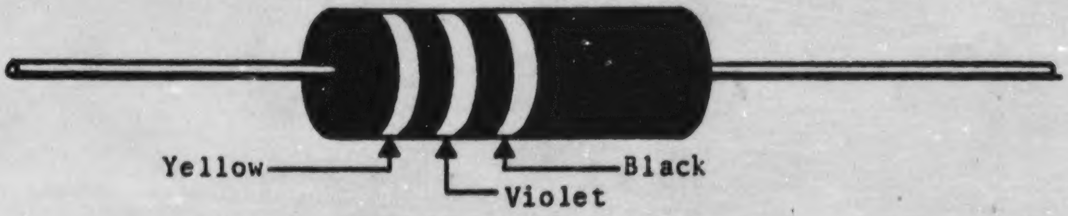
10. If a 100 ohm resistor has a tolerance of 10%, its actual value can be between 90 and 110 ohms. (T-F)

For questions 11 thru 14, record the ohmic values of the color coded resistors.

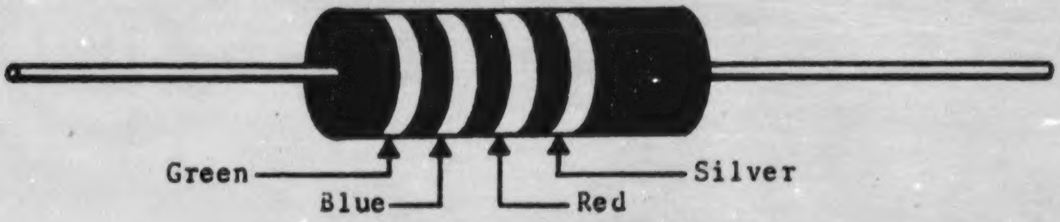
11.


Brown
Red
Brown

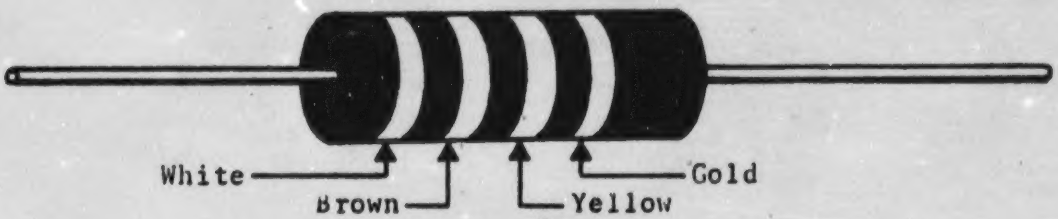
12.


Yellow
Violet
Black

13.


Green
Blue
Red
Silver

14.


White
Brown
Yellow
Gold

For questions 15 thru 18 color code the following resistor value:

1,800,000 Ω ±5%

15. First color band __________

16. Second color band __________

17. Third color band __________

18. Fourth color band __________

For questions 19 and 20, compute the tolerance range for a 6800Ω±10% resistor.

19. Lower value __________

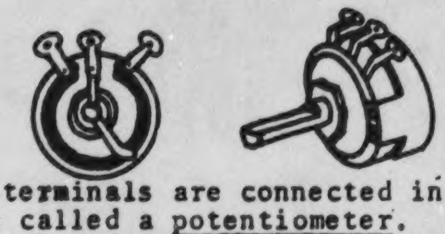
20 Upper value __________

Name: ____________________

Date: ____________________

Period: ____________________

TECHNICAL GLOSSARY

ADJUSTABLE RESISTOR:	A wirewound type resistor, with a movable contact. The resistance between the movable terminal and either end of the resistor can be adjusted by sliding the contact across the resistance element. These resistors are made in such a way that frequent adjustment is impractical.
CARBON COMPOSITION RESISTOR:	The most common type of resistor used in electronic devices. It contains carbon as its resistance material, and uses a series of color bands to code its ohmic value.
COLOR CODE:	The resistor color code utilizes a system of three or four color bands, painted around the resistor, to indicate the "ohm value" of the resistor. Each color in the code translates to a number equivalent.
CONDUCTANCE:	The measure of the ability of a wire or circuit to conduct or allow an electric current flow. Conductance is measured in the basic unit mho or siemens. Letter symbol: G.
FILM RESISTOR:	A type of resistor which offers better accuracy and stability than carbon composition resistors. This resistor utilizes a thin layer of carbon, metal, or metallic oxide as its resistance material.
FIXED VALUE RESISTOR:	A resistor which has only one resistance value. Fixed resistors can be either carbon composition, wirewound, or film type.
OHMIC VALUE:	The ohm rating or value of a resistor.
POTENTIOMETER:	A type of variable resistor consisting of resistance material and a movable arm. A terminal is attached to each end of the resistance material and to the movable arm. The output resistance can be set by adjusting the the movable arm. **POT**  When all three of the terminals are connected into a circuit, the device is called a potentiometer. If only the center terminal (arm) and one of the end terminals is used, the device is called a rheostat.
RESISTOR:	An electrical component used to oppose the flow of electrons through a circuit. Resistors are designed to offer a specific resistance or opposition to current, and this resistance is measured in ohms. Symbol: -/\/\/\- Letter symbol: R.

Name: ____________________

Date: ____________________

Period: ____________________

TOLERANCE:	The amount by which the actual value of a component may vary from its marked value and still be considered good. Tolerances are usually expressed as a percentage. For example, the value of a 1000Ω resistor with a 10% tolerance can vary between 900Ω and 1100Ω.
VARIABLE RESISTOR:	A type of resistor built to be easily adjusted to different values. These resistors provide a continuously variable ohmic value over the range of the device. For example, a 1000Ω variable resistor can be adjusted to any value between 0 and 1000 ohms. Potentiometers and rheostats are variable resistors.
WATTAGE RATING:	A measurement of the amount of power that a resistor can handle in relation to its physical size. Excessive power will cause a resistor to overheat and burn-up.
WIRE GAUGE:	A numbering system used to measure the diameter of wire. The American Standard Wire Gauge system utilizes 40 gauge numbers from 0000 to 6. The larger the gauge number, the smaller the wire diameter.
WIREWOUND RESISTOR:	A type of resistor which offers a combination of high accuracy and high power ratings. These resistors are made by winding a special resistance wire on an insulated core.

R =

Resistance

in

Ω's

SCORE:

GRADE:

Name: ____________________

Date: ____________________

Period: ____________________

WORKSHEET

VOCABULARY - KNOW YOUR DEFINITIONS

Develop a short definition, using your own words, for the following terms. A sketch should be included with your definition when appropriate.

1. COLOR CODE:

2. POTENTIOMETER:

3. RESISTOR:

4. WATTAGE RATING:

5. CARBON COMPOSITION RESISTOR:

6. OHMIC VALUE:

Name: ____________________

Date: ____________________

Period: ____________________

7. FILM RESISTOR:

8. TOLERANCE:

9. WIRE GAUGE:

10. WIRE WOUND RESISTOR:

11. CONDUCTANCE:

12. ADJUSTABLE RESISTOR:

SCORE:

GRADE:

Name: ____________________

Date: ____________________

Period: ____________________

WORKSHEET

RESISTOR COLOR CODING AND DECODING

Determine the resistance value of the following color coded resistors.

EXAMPLE:

	First Band	Second Band	Third Band	Fourth Band	
	yellow 4	violet 7	brown 0	silver ±10%	A. 470Ω ±10%

	First Band	Second Band	Third Band	Fourth Band	
1.	Brown ___	Red ___	Brown ___	None ___	1. ☐
2.	Yellow ___	Violet ___	Orange ___	Silver ___	2. ☐
3.	Orange ___	White ___	Red ___	Gold ___	3. ☐
4.	Blue ___	Gray ___	Black ___	None ___	4. ☐
5.	Green ___	Blue ___	Yellow ___	Gold ___	5. ☐
6.	Brown ___	Black ___	Red ___	Silver ___	6. ☐
7.	Gray ___	Red ___	Orange ___	Silver ___	7. ☐
8.	Brown ___	Gray ___	Green ___	None ___	8. ☐

Name: ____________________

Date: ____________________

Period: ____________________

9. Red ___ Violet ___ Brown ___ Gold ___ 9. ☐

10. Brown ___ Green ___ Blue ___ Silver ___ 10. ☐

Complete the color coding of the following resistors by using the system shown below. This technique can be used when converting a "number value" into a color code equivalent.

3 9 0 0 ± 5%

First Band (orange)

Second Band (white)

Third Band "number of zeros" (red)

Fourth Band "tolerance" (gold)

EXAMPLE:

		1st Band	2nd Band	3rd Band	4th Band		
B.	120Ω ±10%	Brown	______	Brown	Silver	B.	RED
11.	3300Ω ±5%	Orange	Orange	______	Gold	11.	☐
12.	47Ω ±20%	______	Violet	Black	None	12.	☐
13.	680Ω ±10%	Blue	______	Brown	Silver	13.	☐
14.	56000Ω ±10%	______	Blue	Orange	Silver	14.	☐
15.	120000Ω ±5%	Brown	Red	______	Gold	15.	☐
16.	2500Ω ±20%	Red	(A) ______	(B) ______	None	16A.	☐
						16B.	☐
17.	1000000Ω ±5%	Brown	(A) ______	(B) ______	(C) ______	17A.	☐
						17B.	☐
						17C.	☐

EXTRA CHALLENGE: Try this one:

18. Blue ___ Gray ___ Gold ___ Silver ___ 18. ☐

SCORE:

GRADE:

Name: ____________________

Date: ____________________

Period: ____________________

WORKSHEET

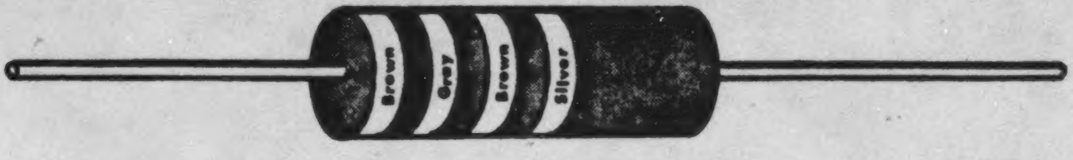
QUEST ACTIVITY

"UNIT 12"

In this activity you will be color coding resistors for an assigned value and computing their tolerance ranges. Cut out the puppets on the attached sheet and use them as the color bands for the blank resistors drawn below. Use colored pencils to shade in each puppet.

EXAMPLE:

A. Color code a 180Ω±10% resistor and determine its tolerance range.

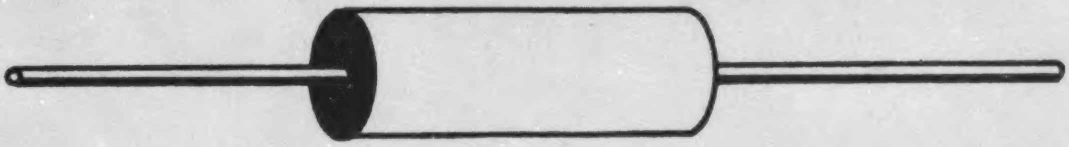


Tolerance range: From 198Ω to 162Ω

Show work:

percentage	upper limit	lower limit
180	180	180
x .10	+ 18	- 18
000		
180	198	162
18.00		

1. Color code a 12000Ω±5% resistor and determine its tolerance range.



Tolerance range: From ____ to ____

Show work:

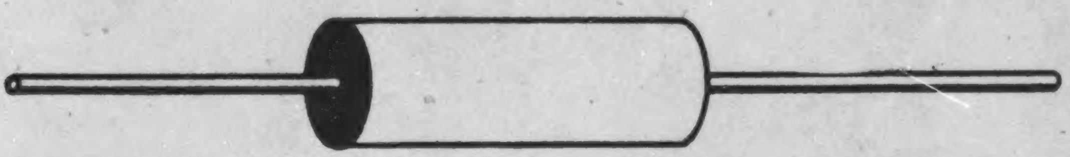
percentage	upper limit	lower limit

Name: ____________________

Date: ____________________

Period: ____________________

2. Color code a 5600Ω±5% resistor and determine its tolerance range.



Tolerance range: From _____ to _____

Show work:

percentage	upper limit	lower limit

3. Color code a 47Ω±20% resistor and determine its tolerance range.

Tolerance range: From _____ to _____

Show work:

percentage	upper limit	lower limit

4. Color code a 850000Ω±10% resistor and determine its tolerance range.

Tolerance range: From _____ to _____

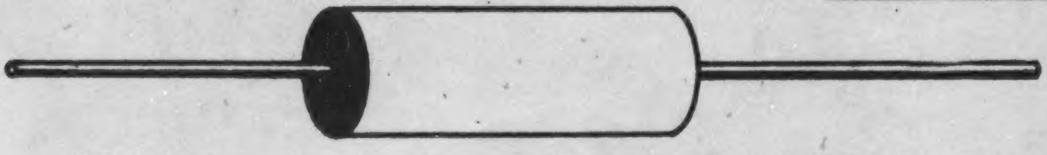
Show work:

percentage	upper limit	lower limit

SPECIAL QUEST:

5. Have your teacher assign you an individual resistance value. Color code that resistor and compute its tolerance range.

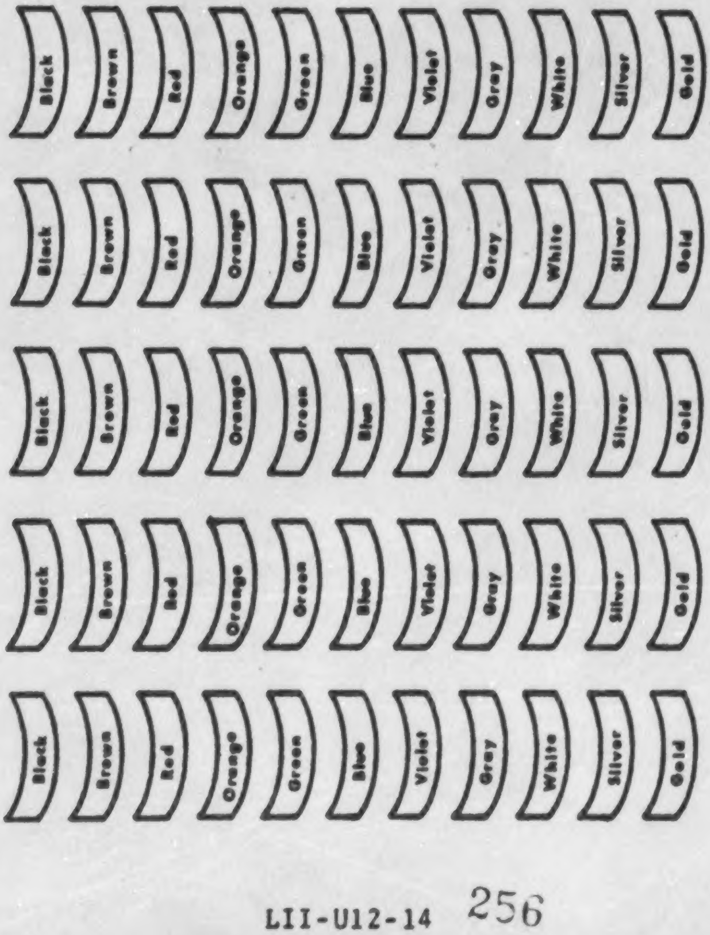
Resistance value: ____________________



Show work: Tolerance range: From _____ to _____

percentage	upper limit	lower limit

CUT


Black
Brown
Red
Orange
Green
Blue
Violet
Gray
White
Silver
Gold
Black
Brown
Red
Orange
Green
Blue
Violet
Gray
White
Silver
Gold
Black
Brown
Red
Orange
Green
Blue
Violet
Gray
White
Silver
Gold
Black
Brown
Red
Orange
Green
Blue
Violet
Gray
White
Silver
Gold
Black
Brown
Red
Orange
Green
Blue
Violet
Gray
White
Silver
Gold

Name: ____________________

Date: ____________________

Period: ____________________

INFORMATIONAL HANDOUT

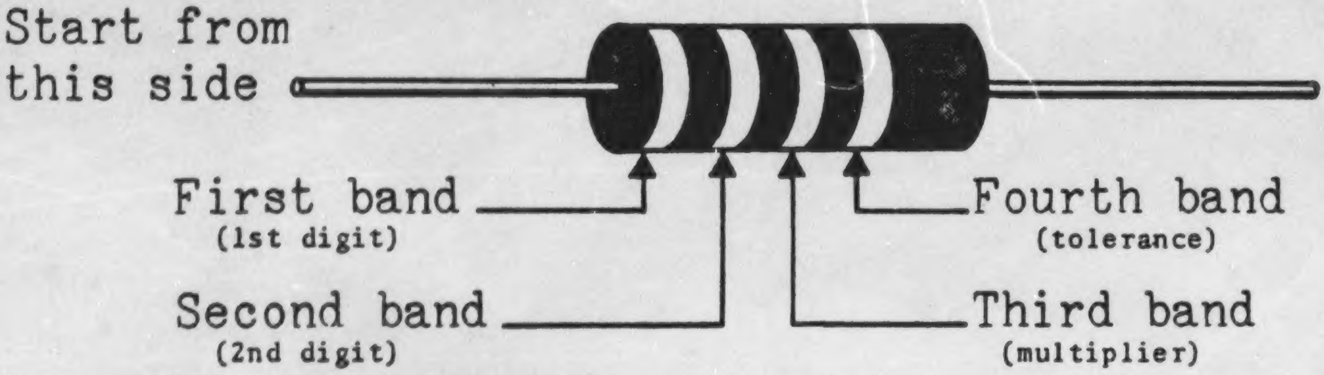
THE RESISTOR COLOR CODE

Carbon composition resistors use a system of three or four color bands painted on the body of the device to indicate its ohmic value. Each color translates into a number or percentage equivalent. Here's how the system works.

Color Code Chart:

	First Color Band	Second Color Band	Third Color Band	Fourth Color Band
Color Code	First Digit	Second Digit	Number of Zeros to Add	Tolerance
0 Black		0	0	No color 20%
1 Brown	1	1	1	Silver 10%
2 Red	2	2	2	Gold 5%
3 Orange	3	3	3	
4 Yellow	4	4	4	
5 Green	5	5	5	
6 Blue	6	6	6	
7 Violet	7	7	7	
8 Gray	8	8		
9 White	9	9		
- Gold	-	-	+ 10	
- Silver	-	-	+ 100	

Locating The Color Bands


Start from this side
First band
(1st digit)
Second band
(2nd digit)
Fourth band
(tolerance)
Third band
(multiplier)

Name: ____________________

Date: ____________________

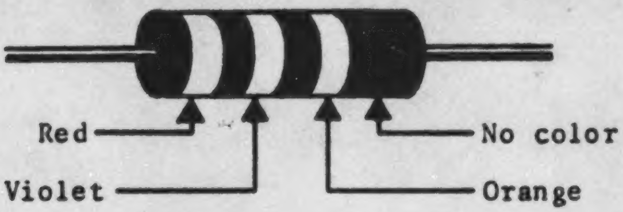
Period: ____________________

Using The Color Code:

Even though it looks a little complicated, using the color code system is actually pretty easy once you have the hang of it. These are the points to remember!!!

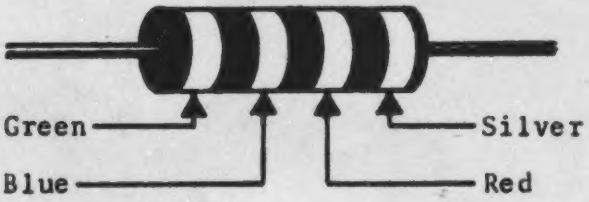
1. The first color band represents the first digit.
2. The second color band represents the second digit.
3. The third color band basically tells how many zeros are added to the first two digits.
4. The fourth color band indicates the ± tolerance.

EXAMPLE:



Red = 2
Violet = 7
Orange = (3)000
No color = ±20%

Total Value 27000Ω ±20%



Green = 5
Blue = 6
Red = (2)00
Silver = ±10%

Total Value 5600Ω ±10%

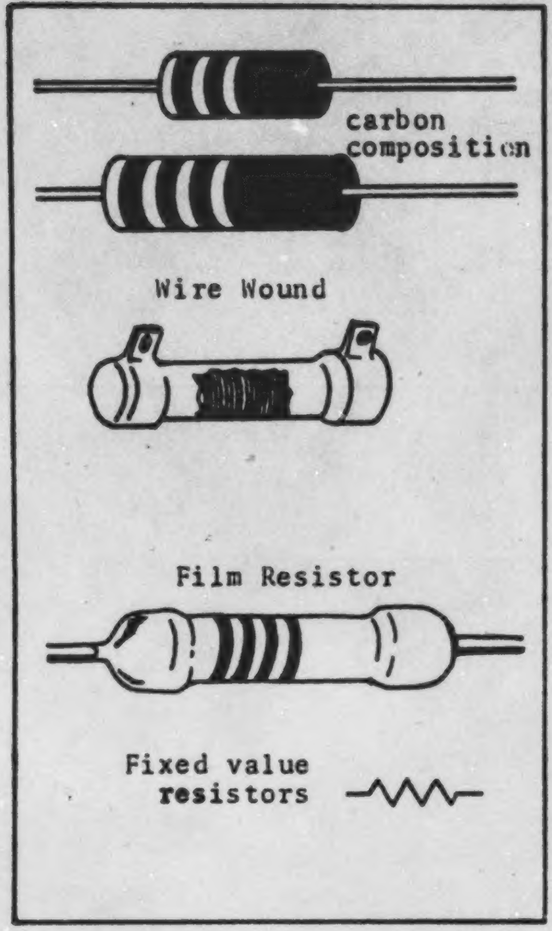
Name: ____________________

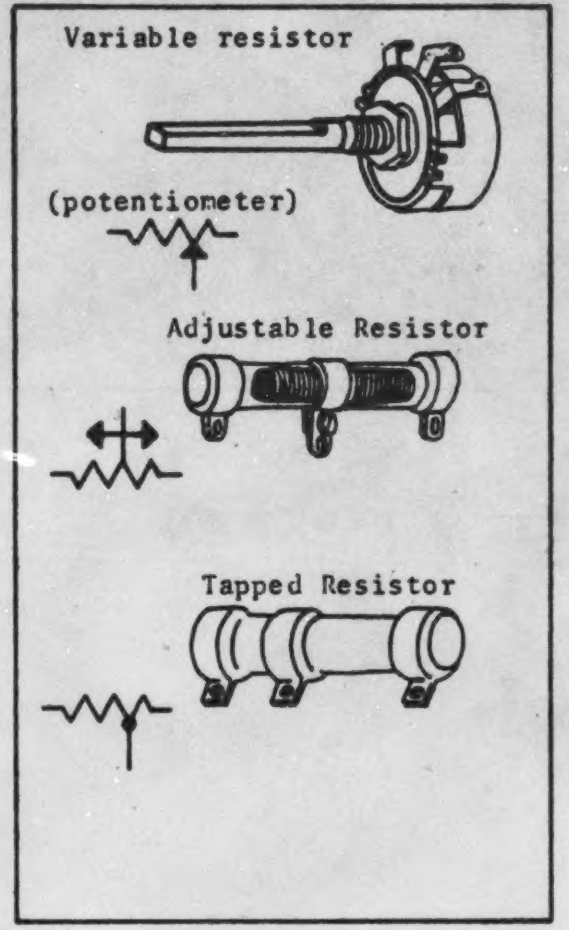
Date: ____________________

Period: ____________________

INFORMATIONAL HANDOUT

RESISTORS - WHAT THEY ARE AND HOW THEY FUNCTION


carbon composition
Wire Wound
Film Resistor
Fixed value resistors


Variable resistor
(potentiometer)
Adjustable Resistor
Tapped Resistor

GENERAL INFORMATION:

A resistor, as the name implies, offers resistance to the flow of electric current. Most electronic circuits require a number of resistors for such tasks as reducing voltages, limiting currents etc.

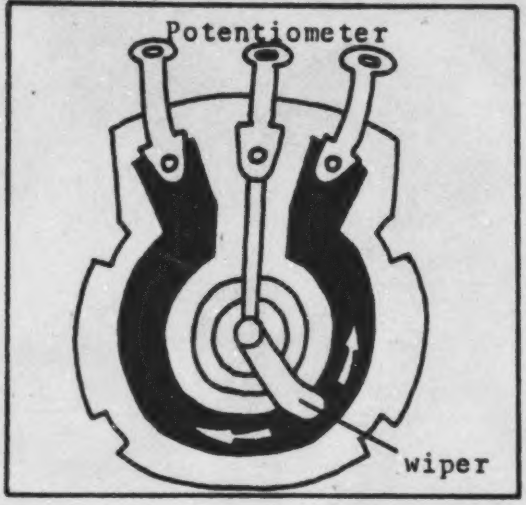
A resistor may be of a fixed, adjustable, or variable value. The terms "potentiometer", "rheostat", and "volume control" are often used interchangeably to describe variable style resistors, but they are not the same thing. A potentiometer or rheostat is a device whose value can be varied mechanically, such as by turning a shaft or moving a slider. A potentiometer is a three terminal variable resistor with connections at both ends and to a center moving contact, while a rheostat is a two terminal variable resistor with a connection to a moving slider, and only one end. Study the diagram on page - 18, it describes the internal connections of both devices. A volume control is a potentiometer used in a specific application

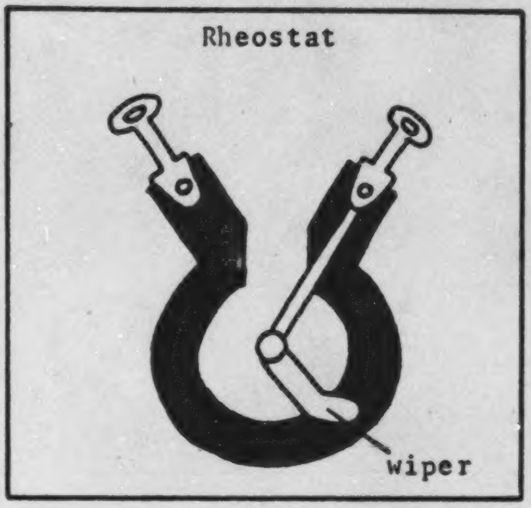
Name: ______________________

Date: ______________________

Period: ______________________

- When connecting fixed value resistors into a circuit you need not worry about polarity. Thus, a resistor may be oriented in either direction in the circuit. Also be aware that resistors produce heat while operating. Many wirewound resistors will produce enough heat to cause serious burns, so be cautious when handling resistors in a circuit that has recently been turned off.





- Resistors are made in three basic types; carbon composition, wire wound, and film. These same materials can be used to construct either fixed value or variable style resistors in a large number of ohmic values.

- All resistors have three important specifications:

VALUE: Given in ohms, kilo ohms (kΩ - thousands of ohms), and megohms (MΩ millions of ohms). The word ohm is often represented by the Greek letter omega - (Ω).

WATTAGE: Specified in watts or fractions of a watt. This is the amount of electrical power the resistor can safely dissipate as heat.

TOLERANCE: Given as a percentage figure, indicates the possible variation in a resistor's actual value from its "normal" rated value. For example, a 1000 ohm, 10% resistor may have an actual value somewhere between 900 and 1100 ohms.

SCORE:	
GRADE:	

Name: ______________________

Date: ______________________

Period: ______________________

ANSWER SHEET

EXAM LII U12

	T A	F B	C	D		T A	F B	C	D		T A	F B	C	D		T A	F B	C	D
1.		■			26.					51.					76.				
2.	■				27.					52.					77.				
3.		■			28.					53.					78.				
4.		■			29.					54.					79.				
5.		■			30.					55.					80.				
6.		■			31.					56.					81.				
7.	■				32.					57.					82.				
8.	■				33.					58.					83.				
9.		■			34.					59.					84.				
10.	■				35.					60.					85.				
11.	120Ω ±20%				36.					61.					86.				
12.	47Ω ±20%				37.					62.					87.				
13.	5600Ω ±10%				38.					63.					88.				
14.	910000Ω ±5%				39.					64.					89.				
15.	brown				40.					65.					90.				
16.	grey				41.					66.					91.				
17.	green				42.					67.					92.				
18.	gold				43.					68.					93.				
19.	6120Ω				44.					69.					94.				
20.	7480Ω				45.					70.					95.				
21.					46.					71.					96.				
22.					47.					72.					97.				
23.					48.					73.					98.				
24.					49.					74.					99.				
25.					50.					75.					100.				

*Show work for problems on back of answer sheet.

ANSWER KEY
UNIT 12

A. KNOW YOUR DEFINITIONS

1. (subjective answer)
2. (subjective answer)
3. (subjective answer)
4. (subjective answer)
5. (subjective answer)
6. (subjective answer)
7. (subjective answer)
8. (subjective answer)
9. (subjective answer)
10. (subjective answer)
11. (subjective answer)
12. (subjective answer)

B. RESISTOR COLOR CODING AND DECODING

1. 120Ω ±20%
2. 47000Ω ±10%
3. 3900Ω ±5%
4. 68Ω ±20%
5. 560000Ω ±5%
6. 1000Ω ±10%
7. 82000Ω ±10%
8. 1800000Ω ±20%
9. 270Ω ±5%
10. 15000000Ω ±10%
11. red
12. yellow
13. grey
14. green
15. yellow

16A. green
16B. red
17A. black
17B. green
17C. gold
18. 6.8Ω ±10%

C. QUEST ACTIVITY

1. brown, red, orange, gold

   tolerance range from 12,000Ω
   to 11,400Ω

2. green, blue, red, gold

   tolerance range from 5,880Ω
   to 5,320Ω

3. yellow, violet, black

   tolerance range from 56.4Ω
   to 37.6Ω

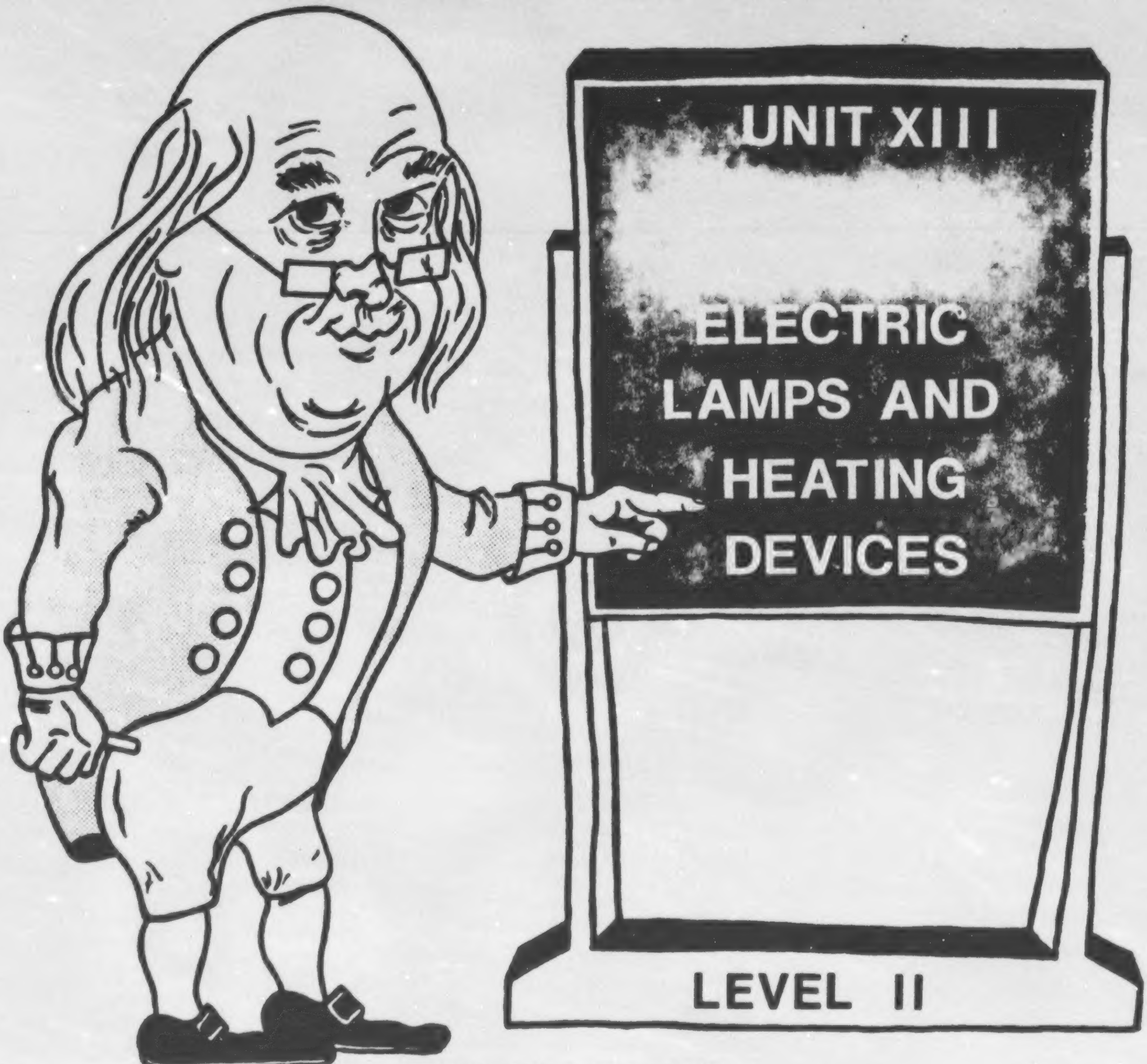
4. gray, green, yellow, silver

   tolerance range from 935,000Ω
   to 765,000Ω

5. (subjective answer)

ELECTRICITY / ELECTRONICS

CURRICULUM GUIDE
INSTRUCTIONAL MODULE



UNIT XIII

ELECTRIC LAMPS AND HEATING DEVICES

LEVEL II

STATE OF CALIFORNIA
DEPARTMENT OF EDUCATION

NAME________________
DATE STARTED__________
DATE COMPLETED________

BY
R. E. LILLO
N. S. SOFFIOTTO

Title of Unit: Electric Lamps and Heating Devices

Time Allocation: 1 week

Unit Goal:

To promote interest and technical understanding of electrical devices employed in basic illumination and heating, and to emphasize the significance of these devices to our daily life styles.

Unit Objectives:

The student will be able to:

1. identify and differentiate operationally between the two major lamp varieties in home use, incandescent and fluorescent.
2. describe the advantages and disadvantages of each lamp variety discussed in this unit and explain the relationship between lamp size and its power rating.
3. explain the concept of heat generation in terms of current flow and resistance, and indicate several applications of this effect.

Evaluation:

The student will demonstrate his/her competence in terms of these measurable objectives based upon individual instructors acceptable performance criteria, which may utilize a combination of written, oral, and laboratory testing procedures.

Instructor References:

Electricity and Electronics Basic. William B. Steinberg and Walter B. Ford, American Technical Society, 1974. Unit: 20.

Introduction to Electricity. Kurt Harding Schick, McGraw-Hill Ryerson Limited, 1975. Chapter: 11.

Understanding Electricity and Electronics. Peter Buban and Marshall L. Schmitt, McGraw-Hill Book Co., 1975. Units: 29 and 33.

Overview:

Unit 13 is presented as a typical technical unit of instruction, however, there is a non-technical aspect that can be incorporated as an effective unit introduction. This instructional topic would deal with the historical development of illuminating devices, which can serve as a fascinating background description while still imparting technical knowledge.

Next, concentrate on the development of the incandescent lamp, and include in its description a detailed analysis of its internal electrical operation.

The topic of glow lamps has been divided into two major sub-categories, but generally emphasis is placed on the fluorescent variety due to its widespread consumer application.

The unit should continue with a brief narrative on the generation of heat from electrical energy. Remember a variety of appropriate exercises and laboratory experiments and/or projects should be coordinated with all unit topics when feasible.

Suggested Presentation Hints/Methodology:

Follow the instructional module unit outline as a basic skeleton for curriculum presentation, however, note the following:

1. When explaining the historical nature of this unit do not rule out a field trip to a museum. Many museums have displays which show the development of lighting and the impact of such a trip is far greater than a lecture presentation.
2. Power ratings may be a subject that can cause some grief at this level, so try to attack this topic from the stand point that this rating indicates the ability of the device to convert electrical energy to either light or heat energy. Have an assortment of devices handy to illustrate the relationship of physical size to the power rating.
3. Do not forget to compare the economics of using an incandescent lamp as oppose to utilizing a fluorescent lamp. Discuss the economy of leaving a fluorescent lamp burning or turning it on and off as light is needed. Additional resource information is generally available from Sylvania, General Electric, and Westinghouse.
4. If time permits, point out that mercury-vapor lamps emit ultraviolet rays and that these are the same type that are used in special application lamps such as sunlamps, blacklight lamps, and germicidal lamps.

Supplemental Activities and Demonstrations:

1. Collect and display a variety of incandescent lamps. Such a collection can either highlight the advances in the use of electricity for illumination, or depict the size an wattage relationships of lamps for a comparative analysis.
2. In depth technical coverage of a fluorescent circuit is optional but if desired a fluorescent lamp circuit should be constructed and used to demonstrate more vividly the fundamental principles of operation. Use this as an opportunity to discuss the advantages and disadvantages of fluorescent lamps.
3. Purchase at the local hardware store a Nichrome heating unit mounted in a socket and demonstrate to the class how this device provides an intense heating source from electrical energy. Discuss its operation in conjunction with the information presented in this unit.

Instructional Module Contents:

1. Unit Outline (overhead)
2. Pre-Post Test (keyed)
3. Technical Glossary
4. Worksheet (vocabulary) - Scrambled Word Puzzle
5. Quest Activity
6. Informational Handout (Historical Development of Illuminating Devices)
7. Informational Handout (Incandescent and Fluorescent Lamps and Circuits)
8. Unit Module Answer Keys

265

XIII. Electric Lamps and Heating Devices

A. Incandescent Lamps
   1. Heating effect

   2. Sizes, voltage, and power ratings

   3. Physical construction

B. Glow Lamps
   1. Neon type

   2. Fluorescent variety

C. Electric Heating Elements
   1. Internal construction

   2. Applications

Test Number _____

LII-U13

UNIT EXAM

IMPORTANT-

Indicate your responses on the answer sheet only. Fill in the box corresponding to the correct answer to each question - there is only one answer for each question.

1. A neon lamp contains a filament. (T-F)

2. When current flows through a filament, heat will be produced . (T-F)

3. The carbon filament incandescent lamp was invented by Thomas Edison. (T-F)

4. The visible light produced by a fluorescent lamp is actually caused by glowing phosphor atoms. (T-F)

5. A glow lamp requires a relatively low voltage (5 to 20 volts) to ionize the gases trapped within it. (T-F)

6. As the amount of current flowing through a heating element increases, the heat produced decreases. (T-F)

7. The wattage rating of a lamp indicates the amount of electrical power the lamp requires for proper operation. (T-F)

8. An incandescent lamp is more efficient to operate than is a similar wattage rated fluorescent lamp. (T-F)

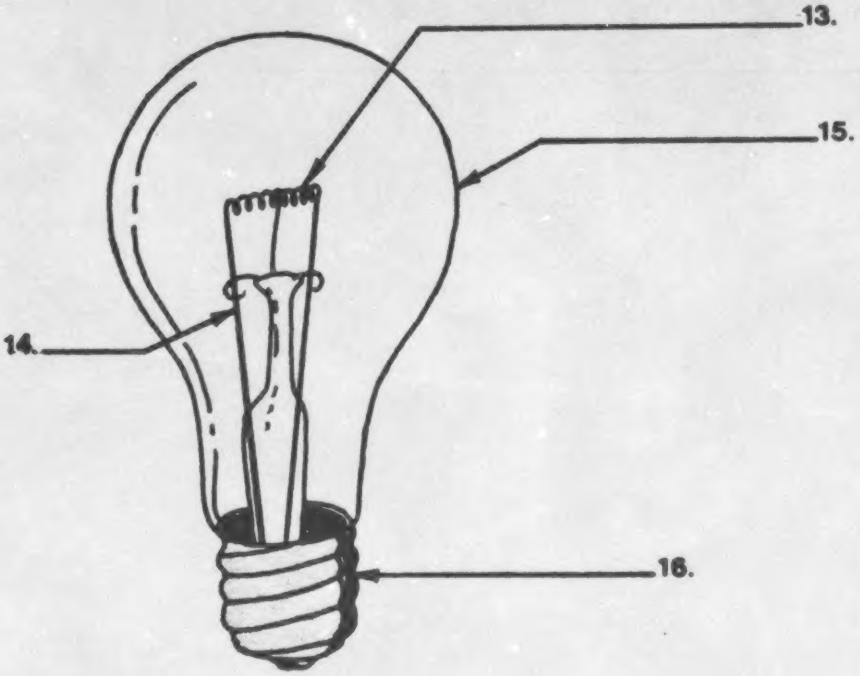
9. The filament in a standard incandescent lamp is made of: (A) copper, (B) nichrome, (C) aluminum, (D) tungsten.

10. The light output of a lamp, either incandescent or fluorescent is given in: (A) lumens, (B) watts, (C) foot-candles, (D) candlepower.

11. For proper operation, a small amount of __________ must be contained within the fluorescent lamp tube.
(A) oxygen, (B) neon gas, (C) mercury vapor, (D) fluorine gas.

12. In order to increase the filament life of an incandescent lamp, the envelope is evacuated, and a small amount of __________ is added.
(A) argon gas, (B) hydrogen gas, (C) indium gas, (D) mercury vapor.

For questions 13 - 20 identify the parts of the incandescent lamp, and fluorescent lamp system pictured below.



13.

14.

15.

16.

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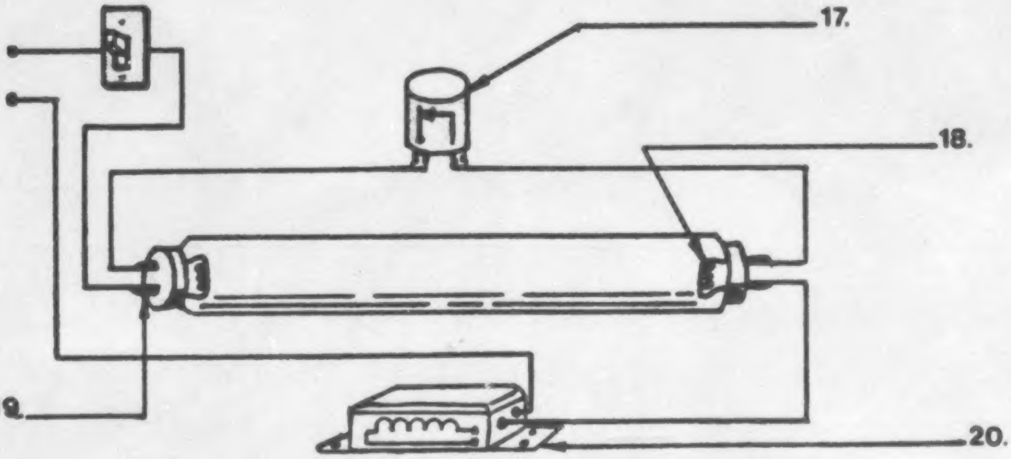
20.



Name: ____________________

Date: ____________________

Period: ____________________

TECHNICAL GLOSSARY

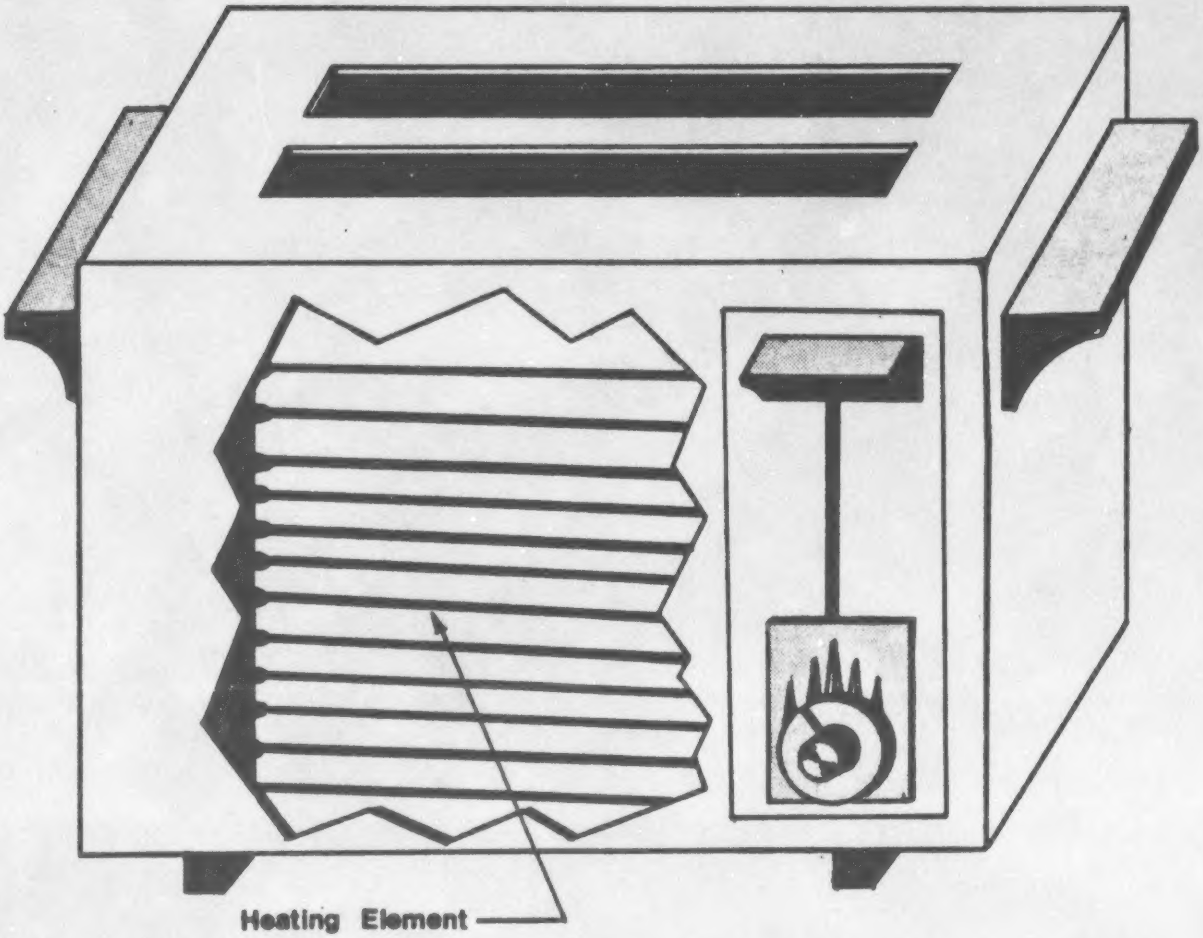
FILAMENT:	The light producing part of an incandescent lamp, made up of a coil of resistance wire (usually tungsten) which heats up and glows as current flows through it.
FLUORESCENT LAMP:	A common type of lamp which operates by passing an electric current through a gas. A typical fluorescent lamp consists of an evacuated glass tube with an inner coating of phosphor, and a tungsten filament sealed into each end. When a high voltage is applied, mercury gas within the tube will ionize and glow. The light produced by the glowing mercury is invisible but when striking the phosphor coating, will cause the phosphor to fluoresce, or glow, producing visible light. Fluorescent lamps have the advandage of high operating efficiency because they waste less energy in the form of heat. A 40W fluorescent lamp will produce approximately 3 times the light that a 40W incandescent lamp will provide.
GLOW LAMP:	A lamp which has no filament. In this type of lamp, the glass envelope is filled with a special gas which will glow brightly when a voltage is applied. Generally this voltage is relatively high, from 55 to several hundred volts. This high voltage causes the gases in the lamp to ionize.
HEATING EFFECT:	A phenomenon which occurs each time an electrical current flows through a wire or a resistance. The simple process of passing a current through a resistance will cause heat to be produced. The amount of heat produced depends upon the amount of current and resistance. This effect is also referred to as I^2R heat.
HEATING ELEMENT:	A device which converts electric energy into heat. Most heating elements are simply a piece of special resistance wire which is able to heat to a high temperature without burning up.
INCANDESCENT LAMP:	The most commonly used type of lamp. Originally invented and manufactured by Thomas Edison. This lamp uses a filament, enclosed in an evacuated glass envelope to produce light. Current, moving through the filament causes it to glow white hot or "incandesce," producing a brilliant light. Modern incandescent lamps use a piece of thin tungsten wire as the filament.
IONIZE:	The process of applying a voltage to a gas, which is contained in an envelope, causing the gas to breakdown or become electrically charged. Once the gas is charged, an electric current is able to flow through the gas, causing it to glow.

Name: ______________________

Date: ______________________

Period: ______________________

NEON LAMP:	A glow lamp which utilizes neon gas to produce an orange colored light. Neon lamps are commonly used as power indicators (on-off indicating lamps) and require a minimum of 55 volts to operate.
POWER RATING:	An electrical measurement which describes the rate at which electrical energy is converted into another form of energy such as heat or light. Power ratings are given in a unit called watts. Symbol: W.
RESISTANCE WIRE:	A special type of wire made of a metal such as nichrome or tungsten which provides a relatively high resistance to current flow. Resistance wire is commonly used to make heating elements, filaments, and wirewound resistors.
VACUUM:	The result of removing the air from a container or envelope. A vacuum means the lack of air and oxygen.



SCORE:

GRADE:

Name: ______________

Date: ______________

Period: ______________

WORKSHEET

VOCABULARY - SCRAMBLED WORD PUZZLE

Unscramble the letters below to uncover the electronic terms.

EXAMPLE:

A.	AMPL	A.	LAMP
1.	ONNE	1.	
2.	ZONEII	2.	
3.	MUACVU	3.	
4.	MEATNILF	4.	
5.	SCCNNNEEDITA	5.	
6.	SCREENTFOUL	6.	
7.	WLGO PLMA	7.	
8.	TEAGHNI FFCTEE	8.	
9.	WREOP NTGRAI	9.	
10.	TSRANECSEI IEWR	10.	

Use a standard dictionary to locate a definition for the following terms:

11. LUMEN: (Lo͞o′ mən)

12. FLUORESCENCE: (Flo͞o′ ə res′ əns)

SCORE:

GRADE:

Name: ______________________

Date: ______________________

Period: ______________________

WORKSHEET

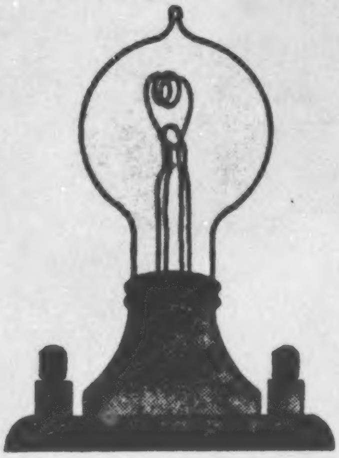
QUEST ACTIVITY

"UNIT 13"

Utilizing the appropriate resource materials, (encyclopedia, books, etc.), write a brief biographical sketch on the life and major accomplishments of Thomas A. Edison.

Thomas Alva Edison

(1847 - 1931)



Name: ______________

Date: ______________

Period: ______________

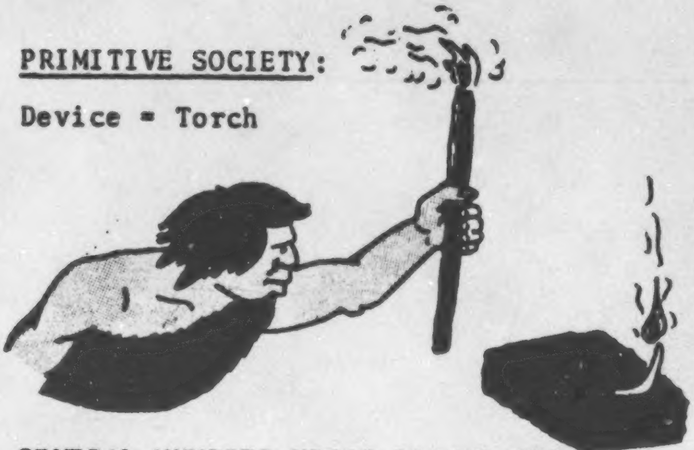
INFORMATIONAL HANDOUT

HISTORICAL DEVELOPMENT OF ILLUMINATING DEVICES

Time Line..........

PRIMITIVE SOCIETY:

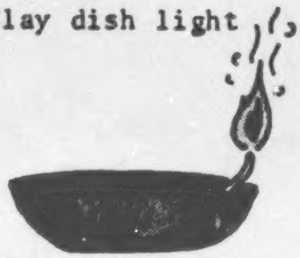
Device = Torch



The historical record should begin with the early cave dwellers who found the means to control fire and illuminate their caves. Soon they began to record events by painting pictures on the walls while holding a torch. Later they created a more functional device by using a hollowed out stone with a fiber for a wick to burn fat which was placed in the hollows.

SEVERAL HUNDRED YEARS BEFORE THE BIRTH OF CHRIST:

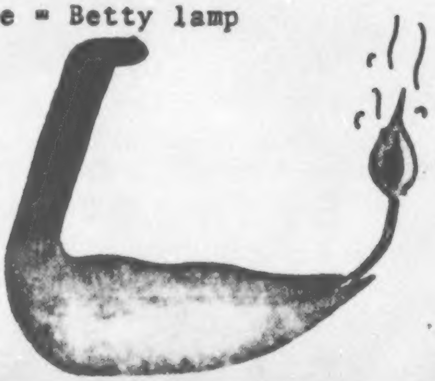
Device = Clay dish light



The Egyptians utilized a simple clay dish light which used oil or grease for fuel with a wick of cotton. This device was easier to handle and a lot more reliable than previous lighting inventiona.

EARLY 1600's:

Device = Betty lamp



Basically the Betty lamp had a wick inserted into a container or vat of animal fat. This may seem crude now but then it was thought of as being an extremely portable device which offered a long burning time. Years later this lamp was modified slightly and the fuel used was either fish oil or whale oil.

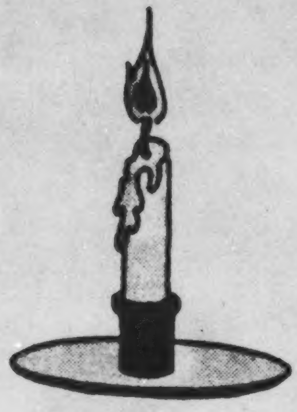
Name: ________________

Date: ________________

Period: ________________

LATE 1600's:

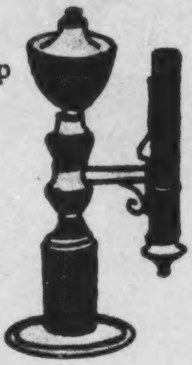
Device = Candle



The candle is truely an ancient lighting device, however the candle was used as a primary source of light in Colonial America and is still used in a limited fashion today. These candles were made by coating a wick with wax and pitch.

LATE 1700's:

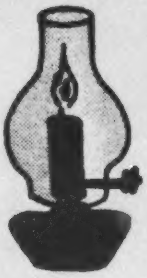
Device = Argand lamp



This lamp contained a hollow type wick and a glass chimney which provided a double current of air for cleaner combustion and a brighter flame. This lamp marked an important improvement or change in illumination devices.

MID 1800's:

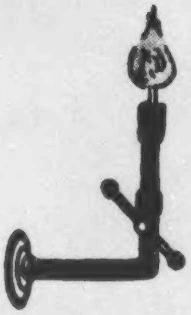
Device = Kerosene lamp



The use of kerosene fuel in lamps was a great improvement in light quality. The addition of a mounted reflector provided maximum light in a given area. This lamp came into existance after the discovery of petroleum (kerosene) in 1859.

LATE 1800's:

Device = Gas lamp



The gas lamp produces light from a small gas flame. The gas flows from the lamp through a small hole and burns after mixing with air.
The gas burned can be butane, coal gas, natural gas, acetylene, etc.
If the flame was blown out gas would fill the room and cause a potentiall dangerous condition.

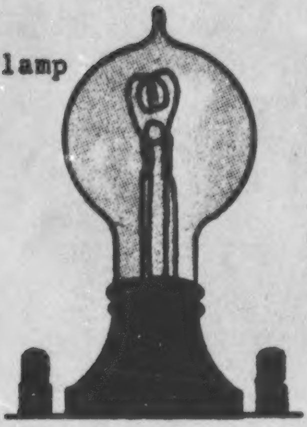
Name: ____________________

Date: ____________________

Period: ____________________

1879:

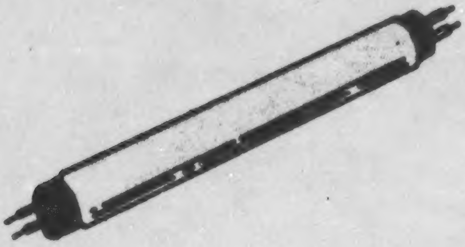
Device = Incandescent lamp



Thomas A. Edison perfected the first practical incandescent lamp. A carbon filament was used because of its ability to glow white hot or "incandesce" under an applied voltage. The light that was given off from the lamp was created without a flame and with minimum of heat to the surrounding area.

1938:

Device = Fluorescent lamp



A common lamp which operates by passing an electric current through a gas. A typical fluorescent lamp consist of an evacuated glass tube with an inner coating of phosphor, and a tungsten filament sealed into each end. When a high voltage is applied, mercury gas within the tube will ionize and glow. The light produced by the glowing mercury is invisible but when striking the phosphor coating, will cause the phosphor to fluoresce or glow, producing visible light. Fluorescent lamps have the advantage of high operating efficiency because they waste less energy in the form of heat.

A THOUGHT:

Through the centuries, people have made many different kinds of illuminating devices. But all of them have been one of three basic types:

1. Fat or oil
2. Gas
3. Elettric

Today, we rely on electric lamps almost entirely for our light.

Name: ______________

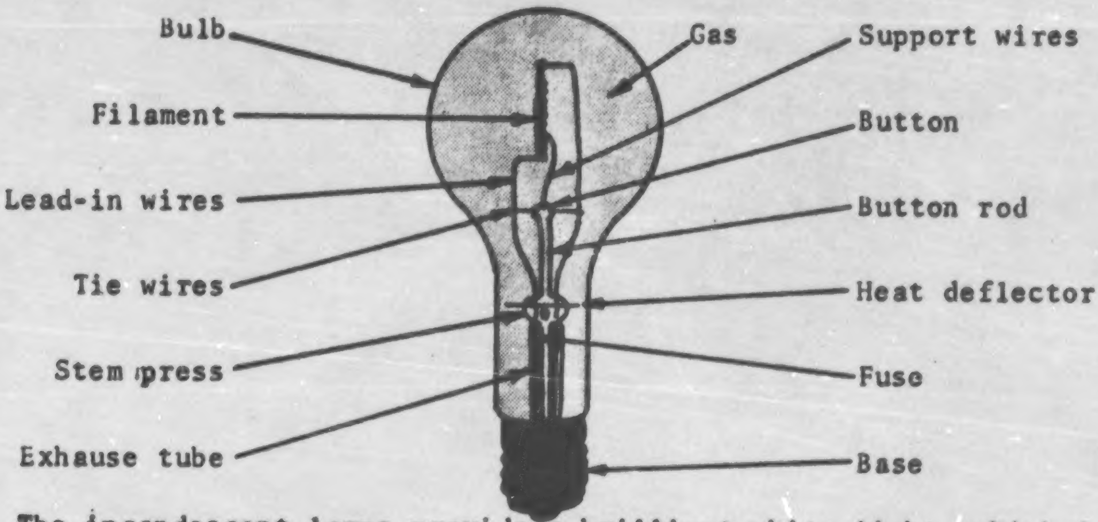
Date: ______________

Period: ______________

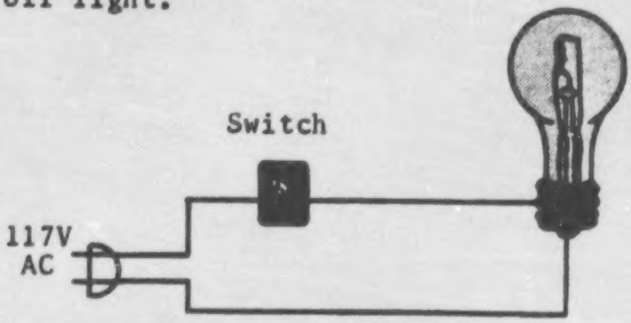
INFORMATIONAL HANDOUT

INCANDESCENT AND FLUORESCENT LAMPS AND CIRCUITS

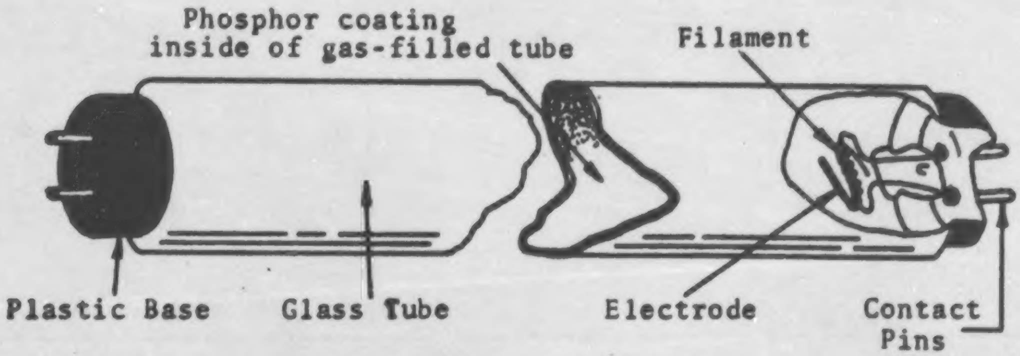
Typical Incandescent Light Bulb and Circuit.


Bulb
Gas
Support wires
Filament
Button
Lead-in wires
Button rod
Tie wires
Heat deflector
Stem press
Fuse
Exhause tube
Base

The incandescent lamps provide a brilliant white light, which is produced by the flow of electrons through the filament. As electrons are forced through the tightly coiled tungsten filament, it begins to heat up, glow, and give off light.


Switch
117V
AC

Typical Fluorescent Light and Circuit.


Phosphor coating
inside of gas-filled tube
Filament
Plastic Base
Glass Tube
Electrode
Contact
Pins

Name: ____________________

Date: ____________________

Period: ____________________

The operation of a fluorescent lamp is rather complex when compared to an incandescent lamp, but there are some similarities. The tube itself has an inner coating of phosphor atoms, and is filled with a gas mixture of argon and mercury vapor. At the extreme ends of the tube, is located a heating filament - electrode unit, this in turn is connected to a set of external contact pins. In addition to the tube, a fluorescent system requires a ballast coil which provides a high voltage pulse for starting the tube and also operates as a current limiting device, and a starter switch which is used to time a heating cycle in which the mercury within the tube is warmed and vaporized.

The starting sequence follows: Once the circuit is energized, the following occurs:

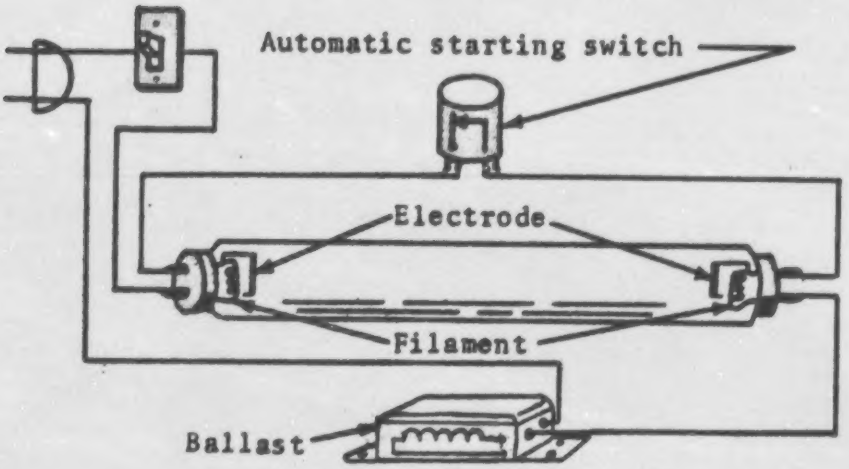
1) The filament units are energized, and warm the mercury within the tube, forming a vapor.

2) At a preset time the starter switch opens, turning off the filaments and causing the ballast to produce a high voltage pulse.

3) This high voltage pulse is applied to the electrodes of the tube, and causes the mercury vapor to ionize and produce invisible light.

4) Once the mercury is ionized, the voltage applied to the electrodes drops to about 120V. The ballast will control circuit current so that an excessive current will not destroy the lamp.

5) So far the tube is only producing invisible light; but as this light energy strikes the phosphor atoms coated on the inside of the tube, it will cause them to glow or "fluoresce," producing visible light.



SCORE:

GRADE:

Name: ________________

Date: ________________

Period: ________________

ANSWER SHEET

EXAM LII U13

	T	F		
	A	B	C	D
1.		■		
2.	■			
3.	■			
4.	■			
5.		■		
6.		■		
7.	■			
8.		■		
9.				■
10.	■			
11.			■	
12.	■			
13.	filament			
14.	lead in wires			
15.	bulb			
16.	base			
17.	starter			
18.	filament			
19.	contact pins			
20.	ballast			
21.				
22.				
23.				
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	T	F		
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*Show work for problems on back of answer sheet.

ANSWER KEY
UNIT 13

A. SCRAMBLED WORD PUZZLE

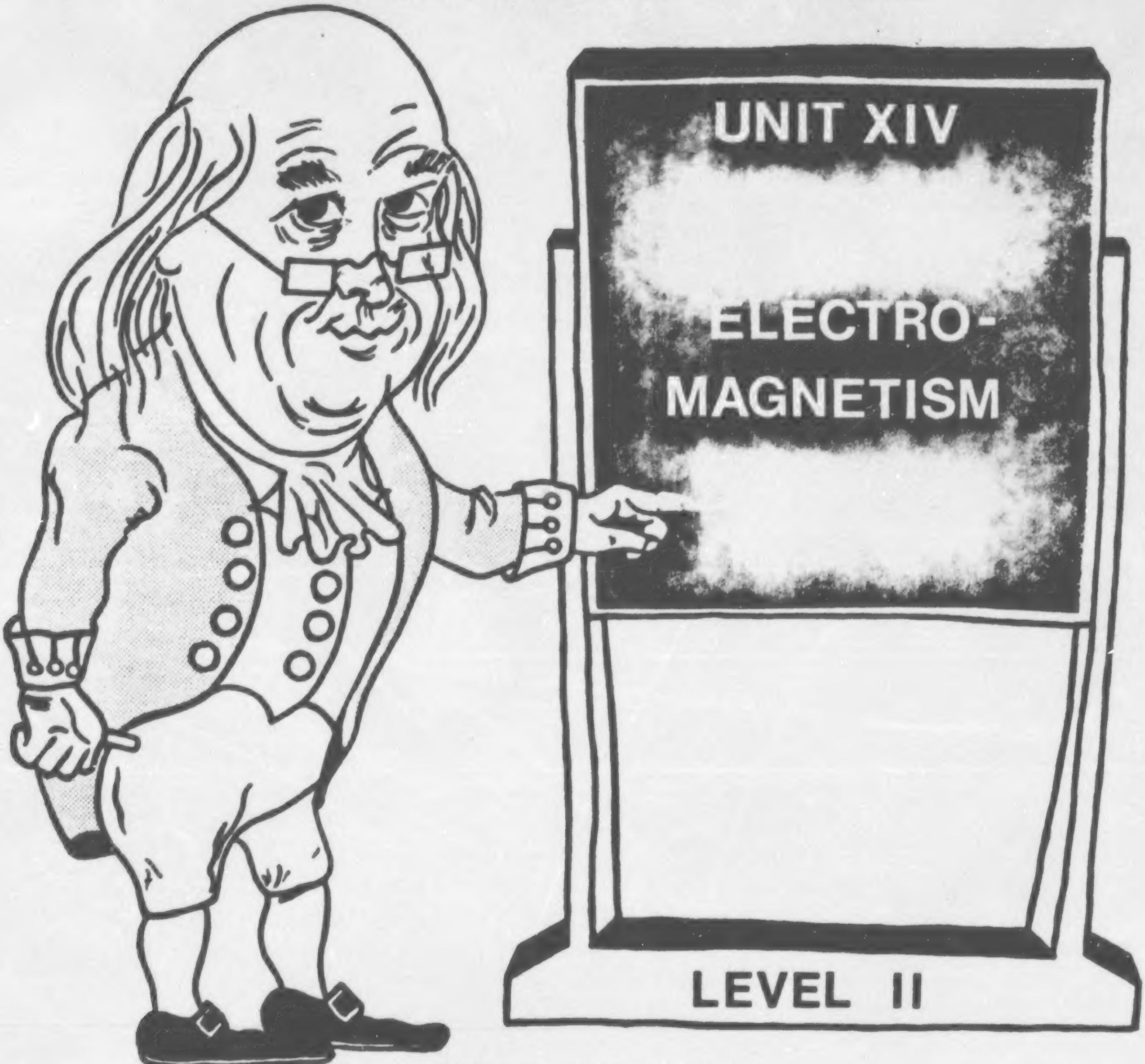
1. neon
2. ionize
3. vacuum
4. filament
5. encandescent
6. fluorescent
7. glow lamp
8. heating effect
9. power rating
10. resistance wire
11. (subjective answer)
12. (subjective answer)

B. QUEST ACTIVITY

(subjective evaluation)

ELECTRICITY / ELECTRONICS

CURRICULUM GUIDE
INSTRUCTIONAL MODULE


UNIT XIV
ELECTRO-
MAGNETISM
LEVEL II

STATE OF CALIFORNIA
DEPARTMENT OF EDUCATION

NAME____________________
DATE STARTED_____________
DATE COMPLETED_________

BY
R. E. LILLO
N. S. SOFFIOTTO

STATE ELECTRICITY/ELECTRONICS CURRICULUM GUIDE
INSTRUCTOR'S GUIDE TO ACCOMPANY LEVEL II UNIT #14

Title of Unit: Electromagnetism

Time Allocation: 2 weeks

Unit Goal:

To broaden and impart greater student competence in terms of comprehending the technical effects, application, and influence that electromagnetism has on our lives, and to discover the inseparable relationship to electricity that the topic electromagnetism enjoys.

Unit Objectives:

The student will be able to:

1. write or recite an explanation describing the cause and effect relationship of the phenomenon referred to as electromagnetism.
2. construct, operate, and explain the fundamental principles of an electromagnet, and identify the specific factors which affect its strength.
3. list and explain the operation of common devices that use the principle of electromagnetism.

Evaluation:

The student will demonstrate his/her competence in terms of these measurable objectives based upon individual instructors acceptable performance criteria, which may utilize a combination of written, oral, and laboratory testing procedures.

Instructor References:

Exploring Electronics Basic Fundamentals. Howard H. Gerrish, Goodheart-Willcox Co., 1971. Unit: 7.

Industrial-Arts Electricity. Clifford K. Lush and Glenn E. Engle, Chas. A. Bennett Co., 1971. Chapter: IV

Introduction to Electricity and Electronics. Orla E. Loper and Arthur Ahr, Delmar Publishers, 1973. Chapter: 6.

Overview:

In Unit 5 of this level students acquired the necessary skills and knowledge to understand the properties of magnets and magnetism. In conjunction with these essential skills this unit will serve as a means to complement those competencies and facilitate an in depth study of a similar topic electromagnetism.

Oersted's discovery is ideally suited as a point of origin for this topic presentation, and it allows a smooth transition into the study of the characteristics of the electromagnetic field.

Next, the electromagnet as a component itself should be analyzed including a heavy highlighting of the methods for increasing the strength of an electromagnet's field.

Unit 14 should conclude with an emphasis on the uses or applications of electromagnets. A variety of appropriate exercises and laboratory experiments and/or projects should be coordinated with all unit topics when feasible.

Suggested Presentation Hints/Methodology:

Follow the instructional module outline as a basic skeleton for curriculum presentation, however, note the following:

1. Try and create with the students an atmosphere of importance about the concept of electromagnetism so that they realize that this topic is one of the most vital to the modern electrical era. Stress that Oersted's discovery has made possible countless devices from electromagnets to motors.
2. Try this activity, "Spell Down": Organize the class into two teams. Using the unit Technical Glossary, the captain of #1 team will call out a term, student #1, team #2 will spell the word, while student #1, team #1, will define it. Alternate this procedure and judge student performance.
3. Before a lecture presentation, use this activity to generate some enthusiasm. Obtain a small, working, black and white TV and tune it for a local channel. Bring a strong electromagnet close to the front of the C.R.T. and let the class watch the picture distort. Discuss the implication of what has been observed.
4. Safety is a prime consideration especially in this unit on electromagnetism. Often students will construct a "homebrew" electromagnet, if they wrap too few turns of wire on a nail, used as the armature, excessive current flows. Obviously this circuit condition is potentially dangerous and must be brought tc the students attention.

Supplemental Activities and Demonstrations:

1. In this unit the student can be made more aware of the many uses for electromagnets by describing and showing them the following devices: speakers, recorder heads, headphones, bells, buzzers, relays, motors, meters, etc. Try to simplify and use practical examples in the explanations and demonstrations.
2. Take some extra time to explore the glossary found in this unit. It is rather large but essential to the understanding of this unit of instruction.
3. Demonstrate the action of magnetic separation by mixing iron filings and sand. Use a strong electromagnet to separate the iron filings from the other ingredient. Discuss the observation.

Instructional Module Contents:

1. Unit Outline (overhead)
2. Pre-Post Test (keyed)
3. Technical Glossary
4. Worksheets (vocabulary) - Crossword Puzzle
5. Quest Activities
6. Informational Handout (Electromagnetic Fields)
7. Unit Module Answer Keys

XIV. Electromagnetism

- A. The Electromagnetic Effect
  - 1. Oersted's discovery
  - 2. Characteristics of the electromagnetic field
    - a. Lines of force around a conductor
    - b. Direction of current flow and its effect on a magnetic field
    - c. Left-hand rule for wire
- B. The Electromagnet
  - 1. Construction
  - 2. Left-hand rule for coils
  - 3. Factors effecting the strength of an electromagnet
- C. Uses of Electromagnets
  - 1. Lifting magnets
  - 2. Relays
  - 3. Solenoid

C. (continued)

4. Buzzers - bells

Test Number ____

LII-U14

UNIT EXAM

ELECTROMAGNETISM

IMPORTANT-

Indicate your responses on the answer sheet only. Fill in the box corresponding to the correct answer to each question - there is only one correct answer for each question.

1. Ferromagnetic materials are those materials which are attracted by a magnet. (T-F)

2. Flux lines are also known as lines of force. (T-F)

3. Because flux lines do not have North and South poles, a compass cannot be used to determine that they do exist around a current carrying conductor. (T-F)

4. The iron core of the electromagnet does not affect the strength of the magnet. (T-F)

5. Like poles repell while unlike poles attract each other. (T-F)

6. A magnetic field is made up of visible flux lines. (T-F)

7. A solenoid is an electromagnet with a movable iron core. (T-F)

8. Permeability is the measure of how long a magnet will remain magnetized. (T-F)

9. An electromagnet is a type of permanent magnet. (T-F)

10. A relay is basically an electromagnetic switch. (T-F)

11. Electromagnetism is an invisible force which attracts any metal. (T-F

12. A temporary magnet has high retentivity or residual magnetism. (T-F)

13. Magnetic lines of force that exist around a conductor are caused by current flow in the conductor. (T-F)

14. Electromagnetism cannot be produced by using alternating current. (T-F)

15. Oersted discovered that an electric current flowing in a conductor will produce magnetism. (T-F)

16. Flux lines exist around a conductor at all times. (T-F)

17. The armature of the relay must be made of a ferromagnetic material. (T-F)

18. Increasing the current flow in a solenoid will increase the strength of the electromagnet. (T-F)

19. When using the left-hand rule for current carrying coils, the thumb points in the direction of current flow. (T-F)

20. Flux lines around a current carrying conductor:
(A) have no specific shape, (B) will appear at only certain places, (C) form a circular pattern around the conductor, (D) have a north and south pole.

21. When two conductors carry opposite currents:
(A) opposite electromagnetic fields are produced, (B) similar electromagnetic fields are produced, (C) no magnetic fields are produced, (D) the two fields repell one another.

22. The left-hand rule states that the thumb points to the north pole when working with:
(A) a coil, (B) a straight wire, (C) a solenoid, (D) both A and C.

23. What causes electromagnetism?
(A) free electrons in the conductor, (B) electrons flowing in the conductor, (C) a conductor, (D) an electric charge.

24. A material that has high retentivity can be used for:
(A) electromagnets, (B) permanent magnets, (C) temporary magnets, (D) paramagnets.

25. When a solenoid is energized with DC, the plunger:
(A) moves to the center of the coil and stops, (B) moves away from the coil, (C) moves into and drops out of the coil, (D) will not move at all.

Name: ______________

Date: ______________

Period: ______________

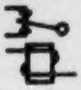
TECHNICAL GLOSSARY

ATTRACT:	The process of drawing or pulling toward an object. For example: a magnet will attract a piece of soft iron.
BELL:	Basically a buzzer with a hammer added to the moving end of the armature. The hammer is designed to strike a bell or gong each time the armature moves toward the electromagnet. The electric bell is one of the oldest household appliances.
BUZZER:	An electromagnetic device which includes a flexible armature, and a switching mechanism. The armature is first attracted to the energized electromagnet. At a certain point, the moving armature causes a switch contact to open, turning off the magnetic field, and allowing the armature to be pulled back by a spring. This reverse motion closes the switch to reenergize the electromagnet and again attract the armature. This process is reapeated over and over again, creating a buzzing sound.
CORE:	The center of a wire coil, which can act as a "form" for the wrappings of wire. The core is used to provide a magnetic path for flux lines, and is commonly made of soft iron, or laminated sheets of iron. Many coils do not use an iron or metal core, but rather use plastic or cardboard tubes; this type of coil is called an air core coil.
ELECTROMAGNET:	A coil of insulated wire wrapped around a soft iron core which becomes magnetic when a current is forced through it. The core acts to concentrate the magnetic line of force. And becomes magnetized when current flows through the coil.
ELECTROMAGNETISM:	The magnetic effect produced when electrons flow through a wire or coil. This invisible field produces both a north and south magnetic pole, similar to a permament magnet. The strength of this field depends upon the magnitude of the current flow, the number of turns of wire in the coil, and the type of core used. If the current flowing through the wire or coil is stopped, the magnetic effect ceases.
FERROMAGNETIC MATERIAL:	A classification for materials which are attracted by a magnet. These magnetic materials include iron, nickel, cobalt, etc.
FLUX LINES:	The lines of magnetic force which exist around a magnet, also known as "Lines of force."

Name: ________________

Date: ________________

Period: ________________

LEFT-HAND RULE:	A method used to determine the polarity of the electromagnetic field surrounding a single conductor, or a coil. In the case of a single conductor, the left thumb points in the direction of electron flow, while the fingers, curled around the wire, indicate the direction of the flux lines. To use the left-hand rule for a coil, wrap the fingers of the left-hand around the coil in the direction of current flow; the thumb will then be pointing toward th coil's north pole.
LIFTING MAGNET:	A very strong electromagnet, commonly used for moving scrap steel. The advantage of the lifting magnet is that the magnetic field can easily be switched on and off.
MAGNETIC FIELD:	The space around a magnet or electromagnet which is influenced or affected by its magnetic force.
MAGNETIC POLE:	The portion of a magnet where the lines of force are most concentrated. In every magnet there is one north-seeking pole (N-pole), and one south-seeking pole (S-pole)
MAGNETISM:	The invisible force, exerted by a magnet, that allows it to attract ferromagnetic materials and to attract or repell other magnets or magnetic fields.
PERMEABILITY:	A measure of how easily magnetic lines of force can pass through a material.
RELAY:	An electrical device, basically a switch, controlled or turned on and off by an electromagnet. Generally, the current flowing to the electromagnet is controlled by a separate circuit. Relays are used in several electronic devices, but they are slowly being replaced by modern solid state switching devices. Symbol:  Letter symbol: K.
REPEL:	The process of pushing away or forcing back of an object. A north pole of a magnet will repel the north pole of a second magnet.
RESIDUAL MAGNETISM:	The magnetism remaining in a material or magnetic core after the magnetizing force is removed. The ability of a material to retain magnetism is referred to as retentivity.
SOLENOID:	A cylindrical electromagnet made with a movable iron core or plunger. When the electromagnet is energized, the plunger is sucked or drawn into the center of the coil. A spring will pull the plunger partially out of the coil when the circuit is denergized. The pulling force of a solenoid can be strong enough to operate switches, locks, valves, or door chimes. Solenoids are also known as sucking coils.

SCORE:

GRADE:

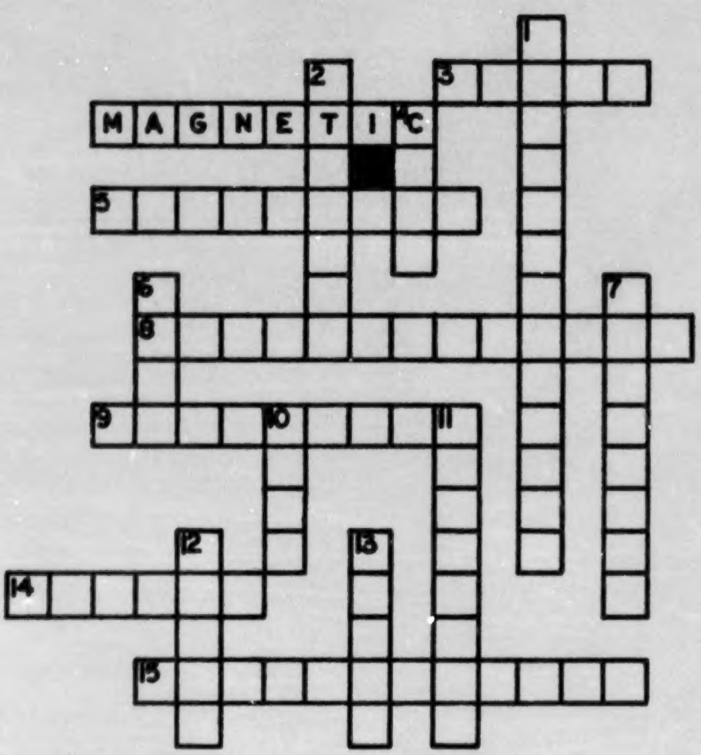
Name: ____________________

Date: ____________________

Period: ____________________

WORKSHEET

VOCABULARY - CROSSWORD



ACROSS

3. The space around a magnet which is influenced by its magnetic force.

5. A type of magnet which loses its magnetism very rapidly once the magnetizing force is removed.

8. A type of magnet which requires a coil of wire, soft iron core, and electric current.

9. The invisible lines of force surrounding a magnet.

14. Electromagnetic device which utilizes flexible, vibrating armature.

15. A measurement of the ease at which flux lines move through a material.

DOWN

1. Materials which are readily attracted by a magnetic field.

2. To draw or pull toward an object

4. Center of a wire coil.

6. One of the oldest household electronic appliances.

7. The magnetism retained by the soft iron core of an electromagnet.

10. A method used to determine the polarity of an electromagnetic field, known as the __________ hand rule.

11. Sucking coil.

12. The opposite of attract.

13. An electromagnetic switch.

SCORE:

GRADE:

Name: ____________________

Date: ____________________

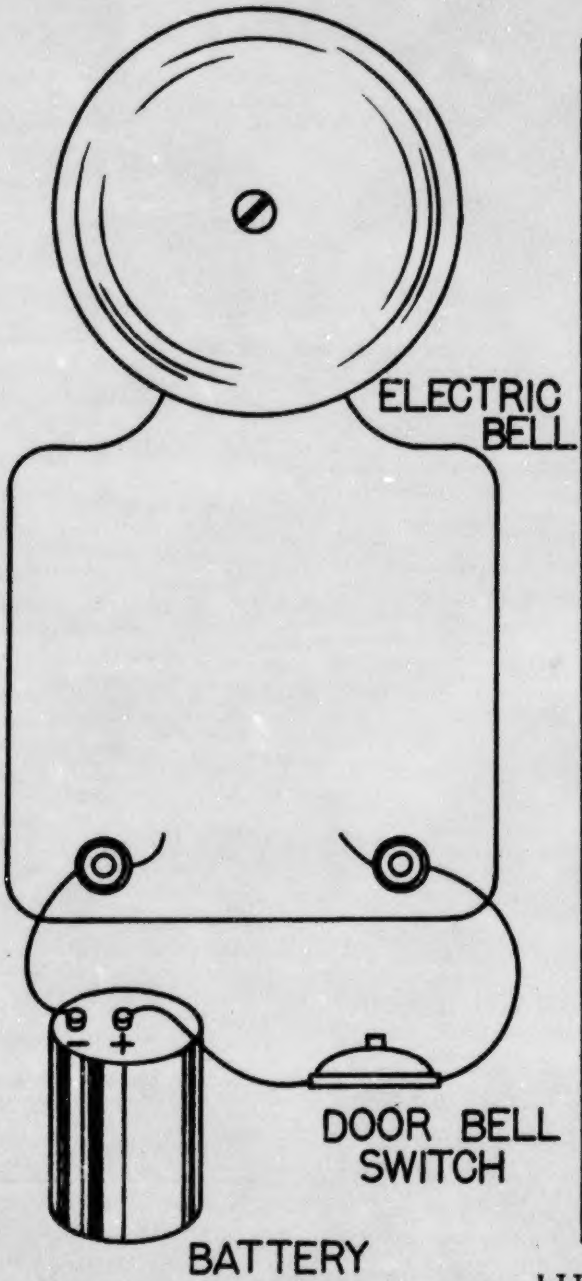
Period: ____________________

WORKSHEET

QUEST ACTIVITY

"UNIT 14"

Complete the drawing of the electric bell, by sketching and labeling the remaining internal and external parts; be complete and accurate. Next, describe in detail the electrical operation of the device - be specific.


ELECTRIC BELL
DOOR BELL SWITCH
BATTERY
−
+

Electrical Operation:

Name: ____________________

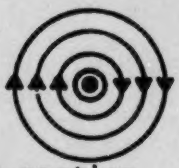
Date: ____________________

Period: ____________________

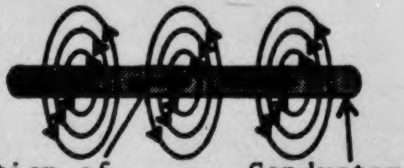
INFORMATIONAL HANDOUT

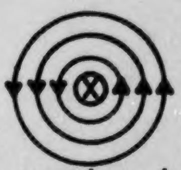
ELECTROMAGNETIC FIELDS

① THE MAGNETIC FIELD AROUND A SINGLE CURRENT CARRYING CONDUCTOR:



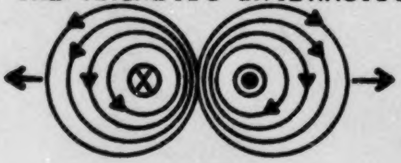
Cross-section drawing of a conductor and magnetic field showing current flowing toward you (●).



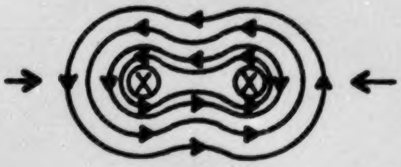


Cross-section drawing of a conductor and magnetic field showing current flowing away from you (X)

② THE MAGNETIC INTERACTION OF TWO PARALLEL CURRENT CARRYING CONDUCTORS:

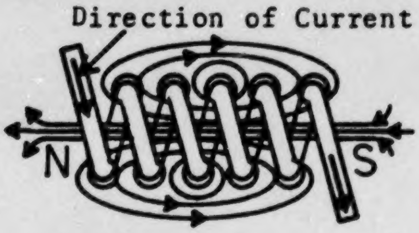


When two parallel wires carry opposite currents, opposite electromagnetic fields are developed. These fields with opposite polarities will repel each other.



When two parallel wires carry a current flowing in the same direction, similar electromagnetic fields are developed. Flux lines flowing in the same direction join, or add, causing attraction.

③ THE MAGNETIC FIELD SURROUNDING A CURRENT CARRYING COIL:



Around a coil, the flux lines are all flowing in the same direction, thus adding together creating a stronger field. The strongest concentration of flux lines will be located within the center or core of the coil.

④ INCREASING THE STRENGTH OF AN ELECTROMAGNETIC FIELD:

- Increasing current flow through a wire or coil will result in the strengthening of the field.
- The addition of more turns of wire to a coil, or wrapping the wires closer together will also cause an increase in magnetic strength.
- Including a soft iron core within the coil will tend to concentrate the magnetic flux lines and produce a stronger field. Thus, the type of core used in the electromagnet will affect its strength.

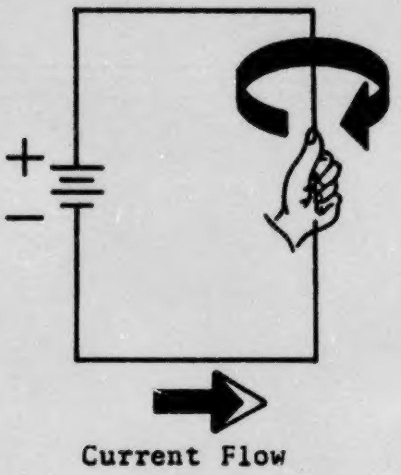
Name: ____________________

Date: ____________________

Period: ____________________

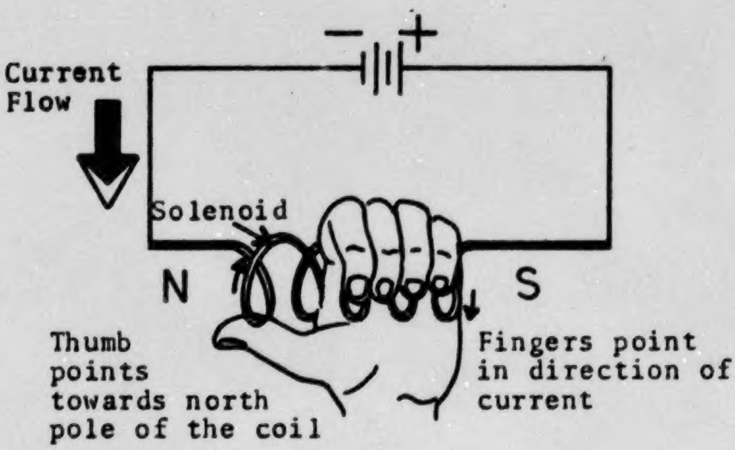
⑤ THE LEFT-HAND RULE:

This form of the left-hand rule is used to determine the direction or polarity of the magnet fields formed around a single conductor or coil.


+
−
Current Flow

To use the-left hand rule for a single conductor, point your left thumb in the direction of current flow; your fingers will then wrap around the wire pointing in the same direction as the magnetic field.

LEFT HAND RULE


− +
Current Flow
Solenoid
N
S
Thumb points towards north pole of the coil
Fingers point in direction of current

When using the left-hand rule for coils or solenoids, simply wrap your fingers around the coil in the direction of current flow; the left thumb will point toward the north magnetic pole of the coil.

SCORE:

GRADE:

Name: ____________________

Date: ____________________

Period: ____________________

ANSWER SHEET

EXAM LII-U14

	T	F				T	F				T	F				T	F		
	A	B	C	D		A	B	C	D		A	B	C	D		A	B	C	D
1.	■				26.					51.					76.				
2.	■				27.					52.					77.				
3.		■			28.					53.					78.				
4.		■			29.					54.					79.				
5.	■				30.					55.					80.				
6.		■			31.					56.					81.				
7.	■				32.					57.					82.				
8.		■			33.					58.					83.				
9.		■			34.					59.					84.				
10.	■				35.					60.					85.				
11.		■			36.					61.					86.				
12.		■			37.					62.					87.				
13.	■				38.					63.					88.				
14.		■			39.					64.					89.				
15.	■				40.					65.					90.				
16.		■			41.					66.					91.				
17.	■				42.					67.					92.				
18.	■				43.					68.					93.				
19.		■			44.					69.					94.				
20.			■		45.					70.					95.				
21.	■				46.					71.					96.				
22.				■	47.					72.					97.				
23.		■			48.					73.					98.				
24.		■			49.					74.					99.				
25.	■				50.					75.					100.				

*Show work for problems on back of answer sheet.

ANSWER KEY
UNIT 14

A. CROSSWORD PUZZLE

ACROSS

3. field
5. temporary
8. electromagnet
9. fluxlines
14. buzzer
15. permeability

DOWN

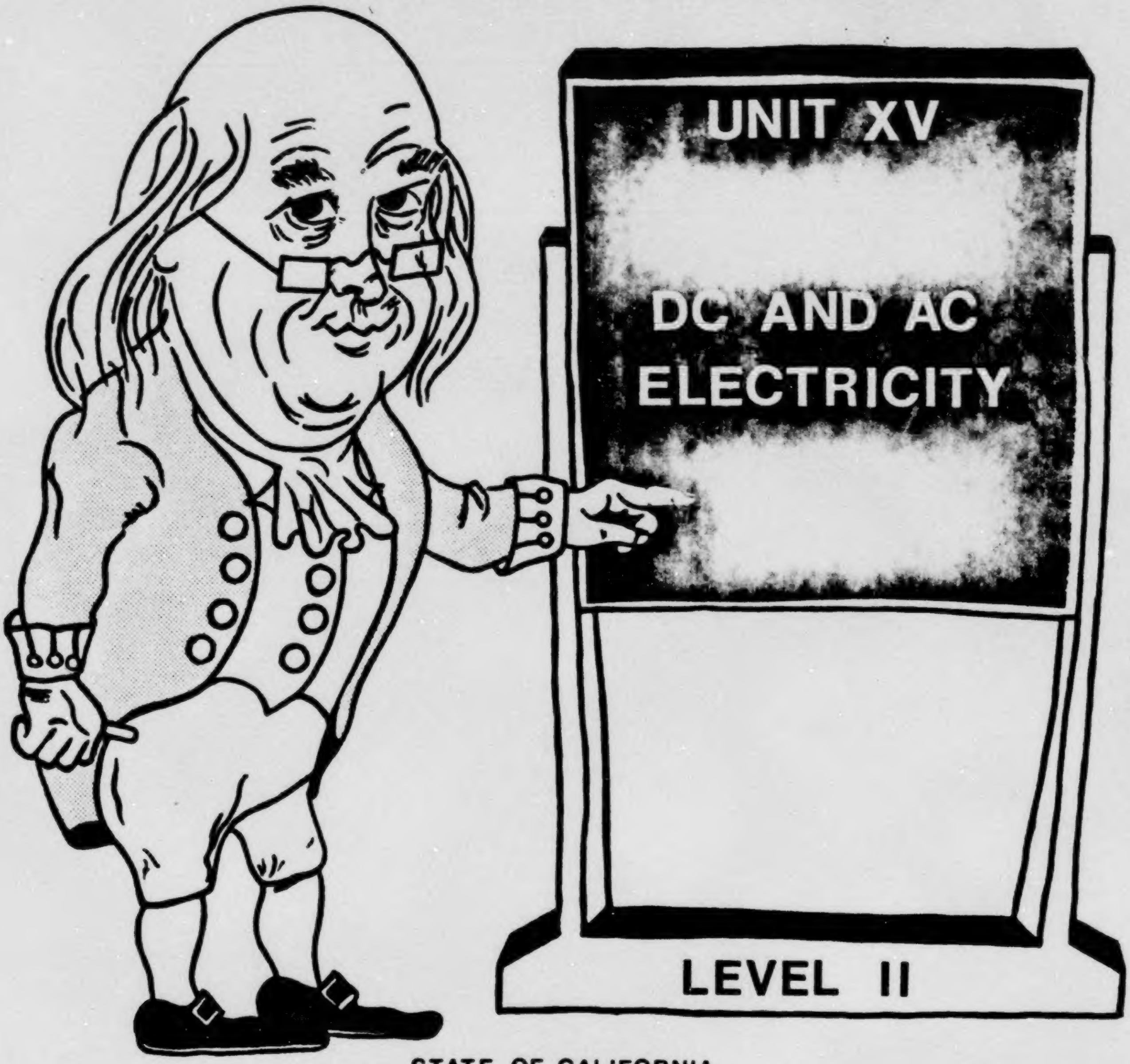
1. ferromagnetic
2. attract
4. core
6. bell
7. residual
10. left
11. solenoid
12. repel
13. relay

B. QUEST ACTIVITY

(subjective evaluation)

ELECTRICITY / ELECTRONICS

CURRICULUM GUIDE
INSTRUCTIONAL MODULE


UNIT XV
DC AND AC
ELECTRICITY
LEVEL II

STATE OF CALIFORNIA
DEPARTMENT OF EDUCATION

NAME____________________

DATE STARTED______________

DATE COMPLETED__________

BY
R. E. LILLO
N. S. SOFFIOTTO

Title of Unit: DC and AC Electricity

Time Allocation: 2 weeks

Unit Goal:

To review, introduce, and infuse fundamental competencies related to the characteristics, terminology, and importance of both DC and AC electricity.

Unit Objectives:

The student will be able to:

1. explain and differentiate between direct and alternating current.
2. name three specific advantages that AC has over DC, and list at least six practical applications of AC.
3. write or recite the major reasons why alternating current is utilized as our primary source of power in the home.

Evaluation:

The student will demonstrate his/her competence in terms of these measurable objectives based upon individual instructors acceptable performance criteria, which may utilize a combination of written, oral, and laboratory testing procedures.

Instructor References:

Electricity One-Seven. Harry Mileaf, Hayden Book Company, Inc., 1976. Chapter: Electricity Three.

Exploring Electricity Electronics With the Electrical Team. Philip J. Rollain and Thomas E. Kraus, Delmar Publishers, 1971. Unit: 17.

Individual Learning Program In AC Electronics. Heathkit Continuing Education, Heath Company, 1976. Unit: 1.

Overview:

Unit 15 was created primarily as a means to briefly examine alternating current. Immediately emphasize to the students that those who plan to work in the electricity/electronics area must be familiar with the basic characteristics of AC.

The unit should be formally introduced with a review of DC current. Once this is accomplished present the specific characteristics, history, and general importance of AC.

Next, concentrate on explaining that electrical devices require a certain kind (AC/DC) of power input in order to operate properly and then examine why this condition exist.

Unit 15 concludes with the students being exposed to the reasons why alternating current is the predominate kind of electrical current being utilized today. A variety of appropriate exercises and laboratory experiments and/or projects should be coordinated with all unit topics when feasible.

Suggested Presentation Hints/Methodology:

Follow the instructional module unit outline as a basic skeleton for curriculum presentation, however, note the following:

1. Do not make this topic more confusing than it has to be. Note, that the unit outline only calls for a brief, yet, informative examination of alternating current, however, do take some time and effort to show the relationship that does exist between alternating and direct current. Unit time is better spent in analyzing the basic characteristics of AC/DC rather than totally exploring the complex nature of alternating current at this time.
2. Students will need the competencies which will allow them the ability to classify electrical devices into their proper power requirement categories. To accomplish this indicate to them that if the electrical device is independent, portable, self contained, and/or requires only a moderate amount of electrical power it probably operates on direct current for its energy requirements.
3. Difficulty in student comprehension occurs when explaining that different kinds of currents sometimes co-exist in the same circuit or device, so expect this problem and be prepared to elaborate on the concept. Also, impress on students that the term signal means AC, yet, some circuits need DC for components to function properly and the AC is what is being processed through the system.

Supplemental Activities and Demonstrations:

1. If an oscilloscope is available in the shop utilize it in the analysis of alternating current. Display waves on the screen for students to view. Students enjoy working with this kind of test instrument and if several students are capable allow them to investigate the subject topic further.
2. Construct and discuss on the blackboard a mock electric power transmission system. Include a power plant, a control center, transmission facilities, distribution lines, and devices for increasing or decreasing the voltage.
3. A description and demonstration on transformer action and rectification is generally easily handled by students as long as the theory is confined to a basic input/output analysis.

Instructional Module Contents:

1. Unit Outline (overhead)
2. Pre-Post Test (keyed)
3. Technical Glossary
4. Worksheet (vocabulary) - Cryptics
5. Quest Activities
6. Informational Handout (DC and AC Current Characteristics)
7. Unit Module Answer Keys

XV. DC and AC Electricity

A. Review of DC Current Characteristics

B. What is Alternating Current?
   1. Back-and-forth motion of electrons
   2. History and importance of AC

C. How Do We Utilize AC and DC Electricity?
   1. Examples of devices operating only on DC

   2. Examples of devices operating only on AC

   3. Combination Devices

D. Why is Alternating Current Our Most Common Form of Electricity?
   1. Efficiency of generation

   2. Effective means of transmission

   3. Conversion ability
      a. Transformer action

      b. Rectification

Test Number _____

LII-U15

UNIT EXAM

DC AND AC ELECTRICITY

IMPORTANT-

Indicate your responses on the answer sheet only. Fill in the box corresponding to the correct answer to each question - there is only one correct answer for each question.

1. You should expect the output voltage of an AC generator to look like a rectangular wave when displayed on an oscilloscope. (T-F)

2. The type of electricity supplied to our homes is DC. (T-F)

3. Radio signals are considered AC type electricity. (T-F)

4. A radio uses both AC and DC type electricity in its operation. (T-F)

5. DC has the advantage that it can be easily changed to AC by using a rectifier. (T-F)

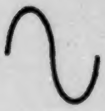
6. Electrons will always flow from negative to positive in a DC circuit, but not necessarily so in an AC circuit. (T-F)

7. Alternating current will travel a longer distance through a transmission line, than a similar value of direct current. (T-F)

8. An alternator is a device used to generate either AC or DC electricity (T-F)

9. The amplitude of an AC wave is a measure of the waves vertical size. (T-F)

10. The frequency of the AC power supplied to our homes is 117V. (T-F)

11. A complete AC cycle can be pictured as follows:  (T-F)

12. The process of changing DC energy to AC energy is called rectification. (T-F)

13. A transformer has the ability to either step-up or step-down an AC voltage. (T-F)

14. High frequency AC signals, called radio waves, can travel through the air over long distances. (T-F)

15. The telephone company uses AC impulses sent over transmission lines to produce sound. (T-F)

16. An alternating current wave changes in:
(A) direction only, (B) value only, (C) both value and direction, (D) frequency and value but not direction.

17. Alternating current is used as:
(A) a source of electrical power and as a means of carrying information or intelligence, (B) a source of power only, (C) a means of carrying information only, (D) an AC signal only.

18. The number of AC cycles produced in one second is called:
(A) an alternation, (B) the sine curve, (C) the frequency, (D) an alternating current.

19. Identify the device which has the ability to convert AC energy of one voltage and current value to another combination of E and I:
(A) rectifier, (B) alternator, (C) transformer, (D) generator.

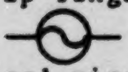
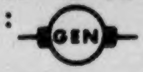
20. Which is an advantage of alternating current?
(A) can be easily changed to DC, (B) can travel a longer distance through transmission lines, (C) can be transformed from one voltage to another with minimal power loss, (D) all of the above.

Name: ____________

Date: ____________

Period: ____________

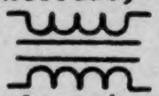
TECHNICAL GLOSSARY

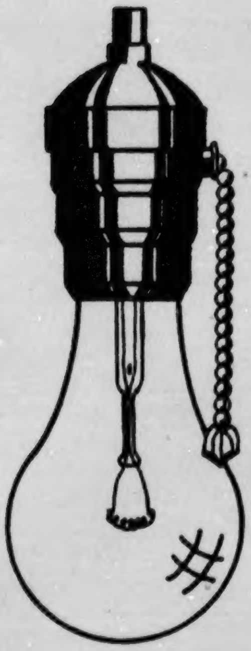
ALTERNATING CURRENT:	A flow of electrons which flow first in one direction, stop, and then flow in the opposite direction. Alternating current can be thought of as a back and forth movement of electrons, varying in amplitude from a maximum to minimum value. The alternating current signal is depicted as a sine wave: Abbrev. AC.
ALTERNATOR:	An alternating current generator that utilizes a stator, rotor, slip rings, and brushes to produce electricity. Symbol:  Letter symbol: GEN.
AMPLITUDE:	The vertical size or height of an alternating current wave.
CYCLE:	One complete alternating current wave. One cycle consists of two alternations, one positive and one negative.
DIRECT CURRENT:	An electric current which flows in one direction through a circuit from negative to positive. Abbrev. DC.
FREQUENCY:	The number of complete AC waves or cycles which occur during a particular amount of time, usually one second. Measured in the basic unit hertz. Symbol: f.
GENERATOR:	A machine used to produce electricity, either AC or DC, by causing a series of interconnecting coils to either cut or be cut by a magnetic field. Symbol:  Letter symbol: GEN.
POWER FREQUENCY:	The frequency of alternating current electricity used for household energy or power. The power frequency used in the United States is 60 hertz.
POWER LOSS:	The loss of electrical energy due to resistance. Power loss is a major problem in transmission lines, where the combination of current flow and wire resistance will produce heat, causing electrical power to be wasted or lost.
RADIO WAVE:	A high frequency alternating current signal used to carry intelligence or messages through the air. Radio waves for example, are used to carry radio and television signals.
RECTIFICATION:	The process of changing alternating current into direct current.
SIGNAL:	A changing AC voltage or current which contains information. Certain AC signals for example can be changed into sound, light, or magnetic pulses.

Name: ____________________

Date: ____________________

Period: ____________________

SINE WAVE:	The output wave produced by an AC generator. One complete sine wave can be drawn as follows: ∿
SOUND WAVE:	A low frequency AC signal which when applied to a speaker will produce sound that can be heard by the human ear.
TRANSFORMER:	An electronic device, made up of two or more coils of wire which has the ability to either step-up (increase) or step-down (decrease) an AC voltage. Symbol:  Letter symbol: T.
TRANSMISSION LINE:	A wire or heavy cable used to conduct or guide electrical energy from one point to another. Transmission lines generally carry high voltages in the neighborhood of 132,000 volts.



PLEASE!

CONSERVE
OUR
ENERGY

SCORE:

GRADE:

Name: ______________

Date: ______________

Period: ______________

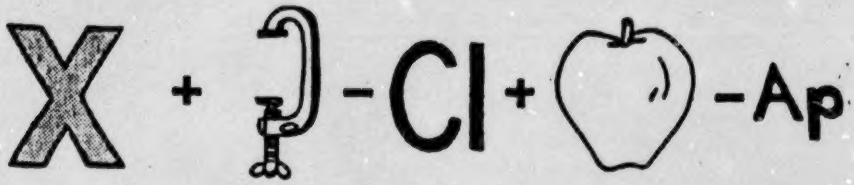
WORKSHEET

VOCABULARY - GLOSSARY CRYPTICS

Decode the cryptic messages below to identify the electronic term.

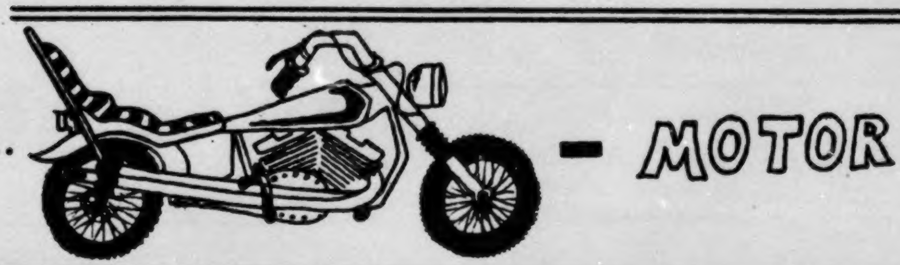
EXAMPLE:

A.



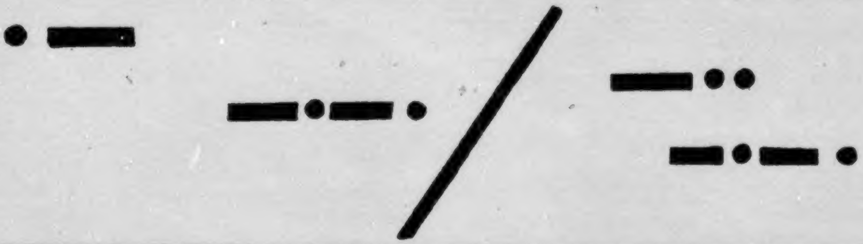
A. EXAMPLE

1.



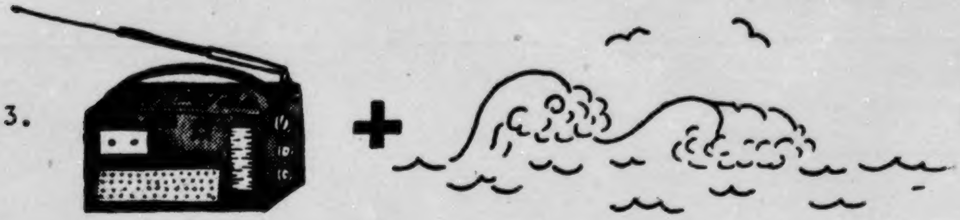
1. ☐

2.



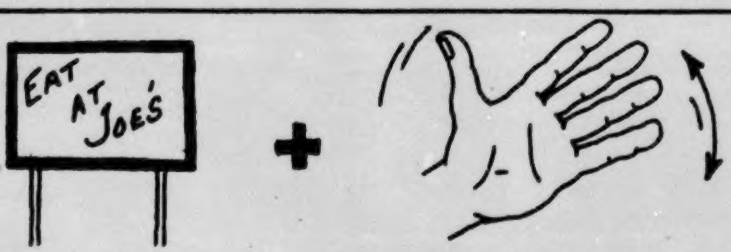
2. ☐

3.



3. ☐

4.



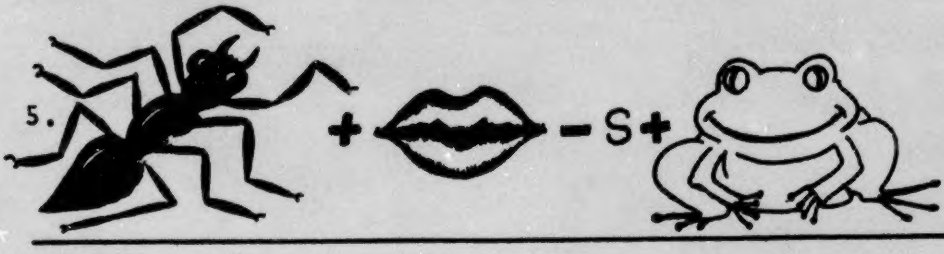
4. ☐

Name: ____________________

Date: ____________________

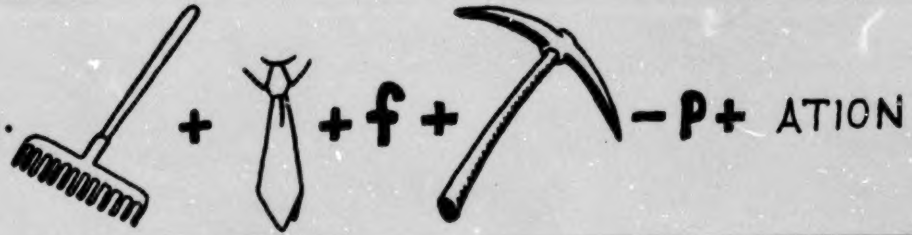
Period: ____________________

5.



5. ☐

6.



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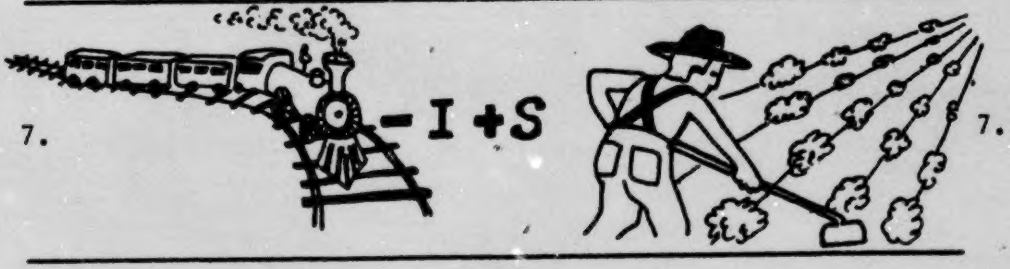

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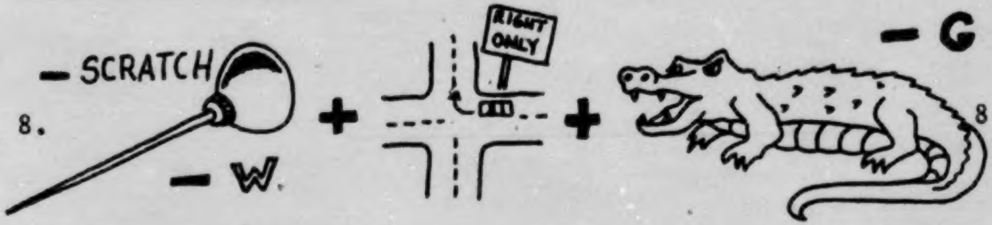
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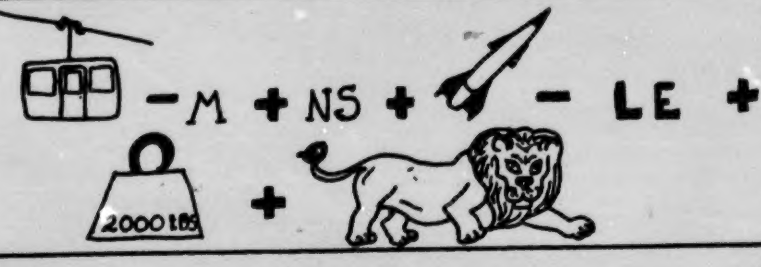
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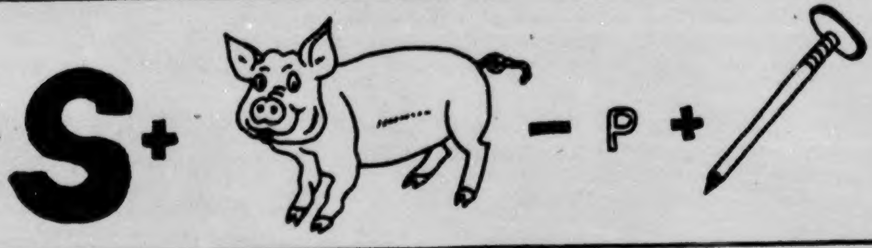

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SCORE:

GRADE:

Name: ______________________

Date: ______________________

Period: ______________________

WORKSHEET

QUEST ACTIVITY

"UNIT 15"

1. Classify the devices listed below according to their primary electrical power requirements. Use the following categories; A) DC operation only, B) AC operation only, or C) combination device, operating on either AC or DC. List the device in the proper column of the chart provided.

DEVICES

flashlight
iron
universal motor
automobile
incandescent lamp
cordless electric razor
electric toy motor
transformer
radio
electric range
washing machine motor
microwave oven

DEVICES

television
door bell
hearing aid
food processor
home movie projector
electric typewriter
electronic flash unit (for cameras)
coffee maker
telephone
portable stereo radio/tape
blow dryer
CB radio - mobile unit

CLASSIFICATION CHART:

	DC Operation Only	AC Operation Only	Combination
A.			
B.			
C.			
D.			
E.			
F.			
G.			
H.			
I.			
J.			
K.			

Name: ____________________

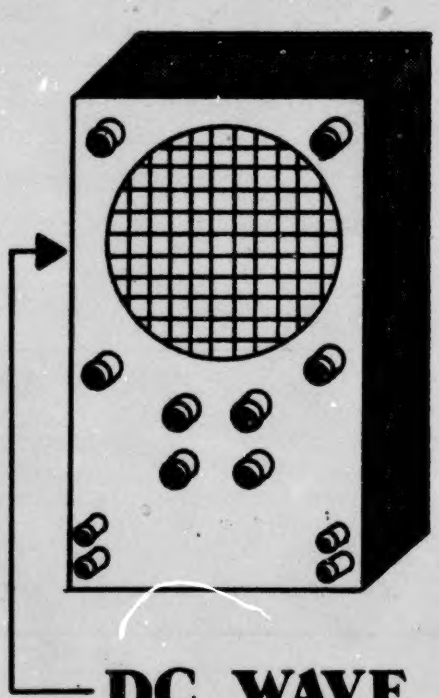
Date: ____________________

Period: ____________________

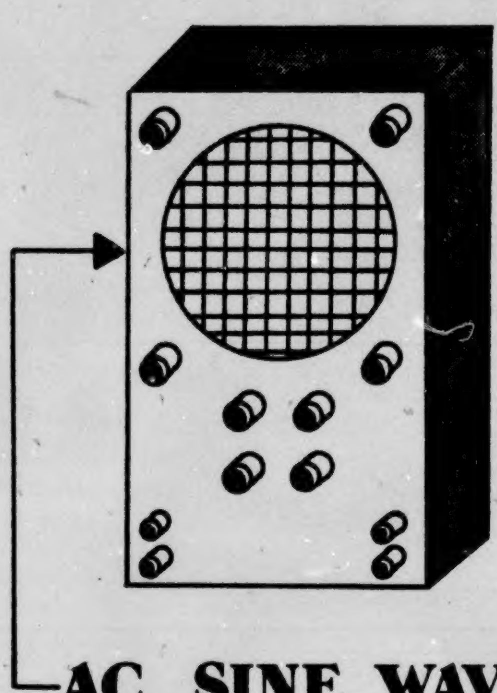
2. Define alternating current:

3. Define direct current:

4. Draw in the appropriate signal or electrical wave on the oscilloscope screens pictured below.



DC WAVE



AC SINE WAVE

Name: ____________________

Date: ____________________

Period: ____________________

5. Describe the four advantages that AC power has over DC power.

A.

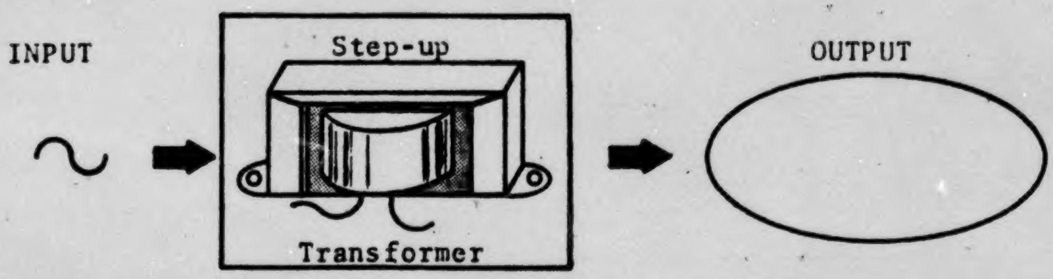
B.

C.

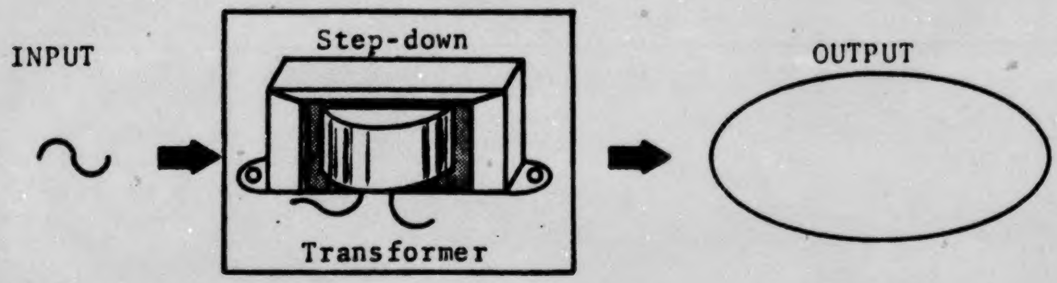
D.

6. Draw the output voltage signal which will be produced by the following devices.

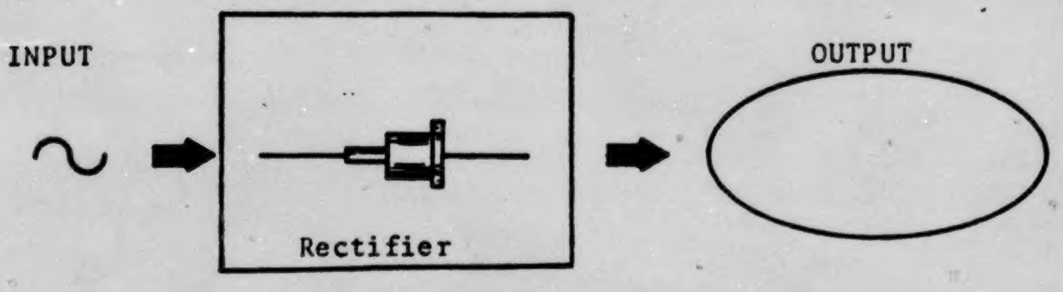
A.


INPUT
Step-up
Transformer
OUTPUT

B.


INPUT
Step-down
Transformer
OUTPUT

C.


INPUT
Rectifier
OUTPUT

Name: ____________________

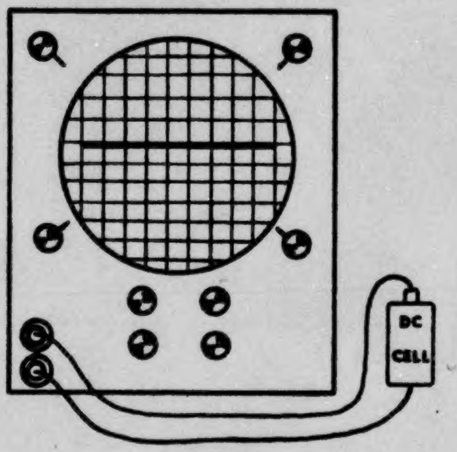
Date: ____________________

Period: ____________________

INFORMATIONAL HANDOUT

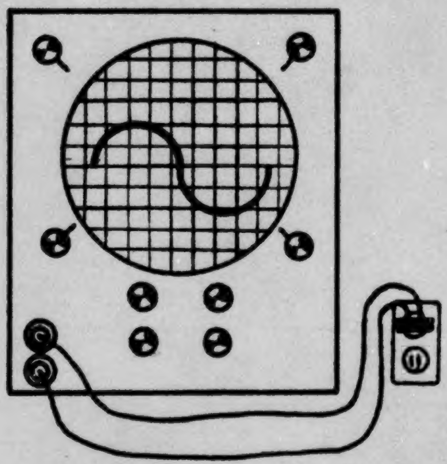
DC AND AC CURRENT CHARACTERISTICS

DC CHARACTERISTICS



- Direct current flows in only one direction through a circuit.
- The polarity of DC current does not change.
- A direct current usually has a steady or constant value.
- Direct current is used exclusively as a source of energy.

AC CHARACTERISTICS



- Alternating current flows in two directions through a circuit, first in one direction, then it reverses, and flows in the opposite direction.
- The polarity of an AC current periodically changes
- An alternating current is continuall changing in value; it will increase from zero to a maximum point in either direction, and then drop back to zero.
- Alternating current can be used as a source of energy, or as an electrical signal - a sound wave, radio wave, or light wave.

DC

AC

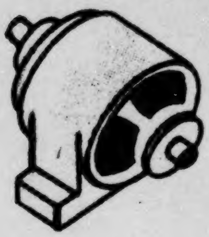
Name: ______________

Date: ______________

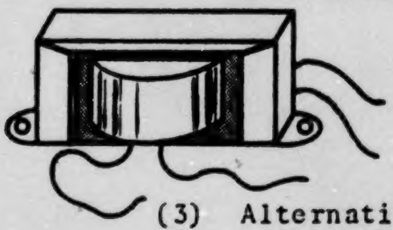
Period: ______________

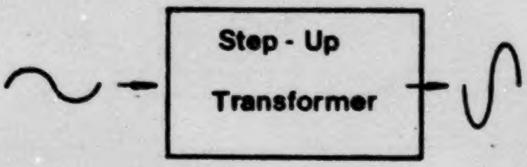
ADVANTAGES OF AC VS DC CURRENT

(1) AC generators are less complex than DC generators; they can be constructed in larger sizes, and are more economical to operate. Thus, AC is easier and cheaper to produce.

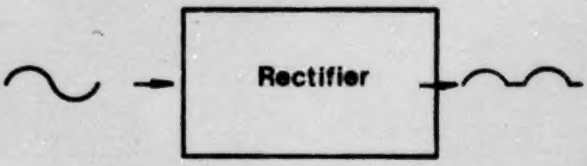


(2) An AC voltage can be easily stepped-up (increased), or stepped down (decreased), with very little loss of power, by using a transformer.

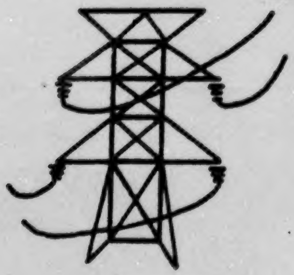




(3) Alternating current is easily converted into direct current, by a diode or rectifier. This converted alternating current, now direct current, can be used to operate various DC circuits.



(4) Because of the ease by which alternating current is transformed to high voltages, it becomes more efficient to transmit on power lines. AC signals can also travel a longer distance through the air than direct current.



SCORE:

GRADE:

Name: ________________

Date: ________________

Period: ________________

ANSWER SHEET

EXAM LII-U15

	T A	F B	C	D
1.		■		
2.		■		
3.	■			
4.	■			
5.		■		
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7.		■		
8.	■			
9.	■			
10.		■		
11.	■			
12.		■		
13.	■			
14.	■			
15.	■			
16.			■	
17.	■			
18.			■	
19.			■	
20.			■	
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	T A	F B	C	D
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	T A	F B	C	D
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98.				
99.				
100.				

*Show work for problems on back of answer sheet.

ANSWER KEY
UNIT 15

A. GLOSSARY CRYPTICS

1. cycle
2. AC/DC
3. radio wave
4. sign wave
5. amplitude
6. rectification
7. transformer
8. alternator
9. transmission
10. signal

B. QUEST ACTIVITY

1. DC
flashlight
auto
razor
toy motor
hearing aid
flash unit
telephone
portable radio/tape
CB radio - mobile

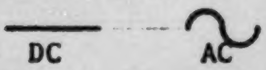
AC
iron
incandescent lamp
transformer
range
washing machine
oven
door bell
food processor
movie projector
typewriter
coffee maker
blow dryer

COMBINATION
radio
universal motor
television

2. Current that changes from 0 to some maximum value and then to 0 again, then reverses direction and changes from 0 to maximum in that direction and then back to 0.

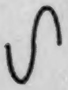
3. That current that flows in one direction only and does not reverse itself.

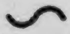
4\.

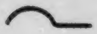


5. A. easily transformed up or down
B. easy transmission
C. easy to rectify to DC
D. efficient generation

6\.

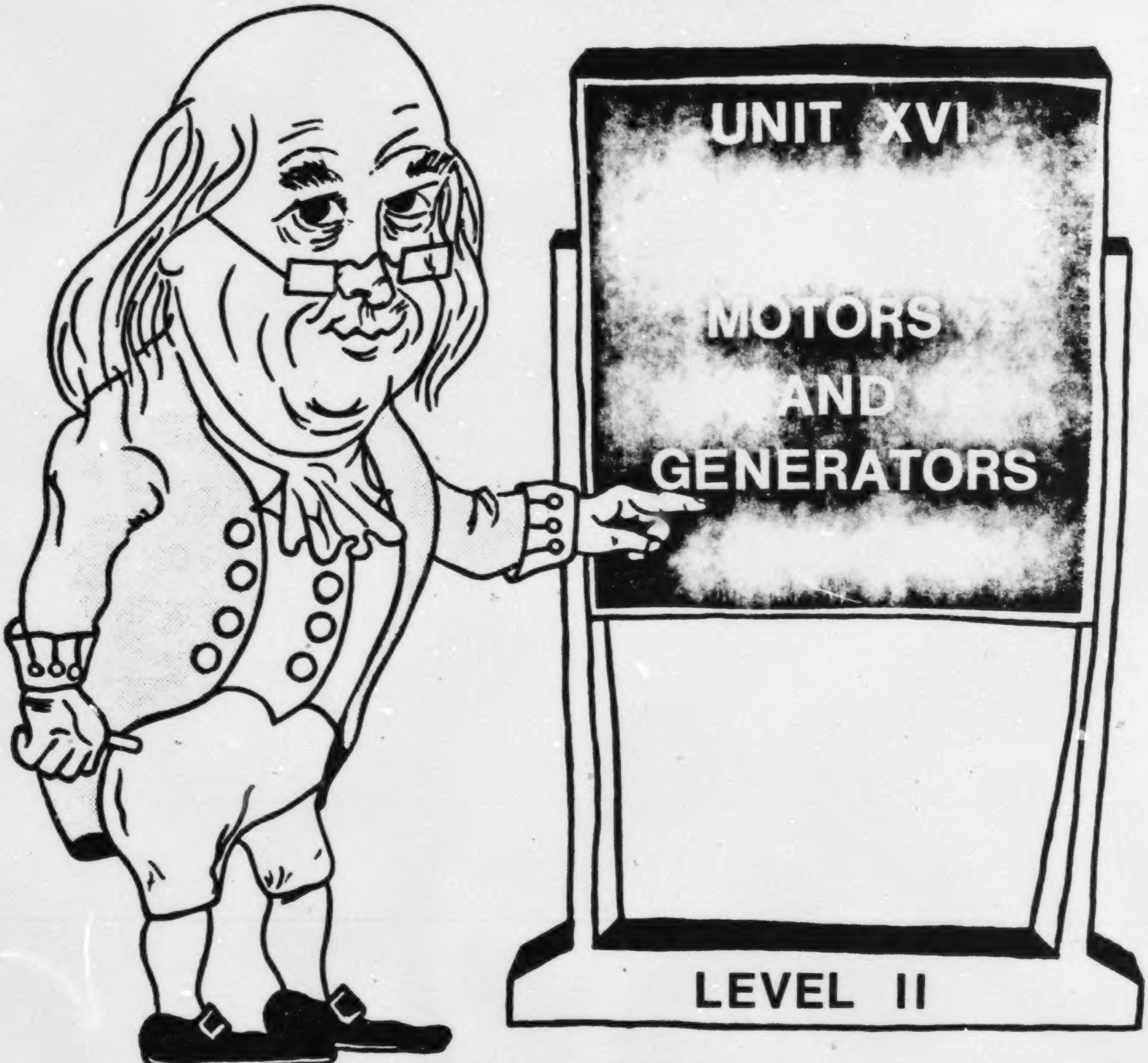
A. 

B. 

C. 

ELECTRICITY / ELECTRONICS

CURRICULUM GUIDE
INSTRUCTIONAL MODULE


UNIT XVI
MOTORS
AND
GENERATORS
LEVEL II

STATE OF CALIFORNIA
DEPARTMENT OF EDUCATION

NAME________________

DATE STARTED__________

DATE COMPLETED________

BY
R. E. LILLO
N. S. SOFFIOTTO

STATE ELECTRICITY/ELECTRONICS CURRICULUM GUIDE
INSTRUCTOR'S GUIDE TO ACCOMPANY LEVEL II UNIT #16

Title of Unit: Motors and Generators

Time Allocation: 2 weeks

Unit Goal:

To familarize students with the general application, operation, and diversity of both motors and generators, and to explore some of the available power energy sources and distribution systems of the 20th Century.

Unit Objectives:

The student will be able to:

1. state the purpose and fundamental principles of operation in respect to the electrical motor and generator.
2. explain several typical commercial applications of DC or AC motors, and list four specific causes of motor failure.
3. identify, compare, and contrast the variety of modern energy sources which may be utilized in the generation of electrical power, and describe the common kind of distribution system which is employed to deliver this power to the consumer.

Evaluation:

The student will demonstrate his/her competence in terms of these measurable objectives based upon individual instructors acceptable performance criteria, which may utilize a combination of written, oral, and laboratory testing procudures.

Instructor References:

Electricity and Electronics. Howard H. Gerrish and William E. Dugger, Goodheart-Wilcox Company, Inc., 1977. Chapters: 5 and 9.

Electronic Communication. Robert L. Shrader, McGraw-Hill Book Company, 1975. Chapter: 23.

Industrial Electricity. Rex Miller, Chas. A. Bennett Co., 1978. Chapters: 1, 2, 3, 14, and 15.

Overview:

This unit, because of its technical content and depth of subject matter, can be presented, modified, or omitted as desired by the instructor to facilitate individual program needs. Unit 16 should be introduced with a simple review of units 5, 14, and 15 of Level II to allow a smoother transition into the topics of motors and generators.

Remember at this level the instructor is only presenting a rather shallow overview of the methods in which energy can be converted to attain either mechanical or electrical power.

Servicing techniques, troubleshooting, maintenance, and specific causes of motor failure are topics which can create student interest and have tremendous practical application.

This unit should conclude with a stimulating discussion and demonstration on the types of energy sources and distribution systems that are currently being used and those that are being developed to meet society's future power consumption needs.

Suggested Presentation Hints/Methodology:

Follow the instructional module unit outline as a basic skeleton for curriculum presentation, however, note the following:

1. Allow the class to examine and investigate the physical construction of a simple motor and generator device prior to a discussio of the basic principles of operation. If possible use a large "cutaway" model of each to enhance student comprehension of the fundamental parts and their general location.
2. When appropriate, try to compare the applications of DC or AC motors and DC or AC generators. This will assist the students in organizing their own thoughts in terms of the device and its function.
3. The topic of power plants and their operations is not only technically informative, but can even be considered controversal leading to some interesting classroom activities if the student are directed. Specifically, nuclear power plants and reactors in reference to safety and future needs can certainly form the foundation of a fascinating class discussion.
4. Do not overlook your local power company as a real fine resource for support materials for instructing students on the topics of motors, generators, power plants, distribution systems, alternative power sources, and career information. It is not uncommon for these companies to supply interested educators with films, film-strips, tapes, posters, worksheet masters, guest speakers, and a variety of other media related assistance.

Supplemental Activities and Demonstrations:

1. Have a small group from the class develop a visual aid depicting how electricity is created. Begin the diagram with the arrival of the fuel at the power plant and continue through the production of electricity and its distribution to the consumer.
2. The following informational sources will provide data on solar energy. Have several students write and share their materials.

National Solar Heating and Cooling
Information Center, P.O. Box 1607
Rockville, MD 20850

U. S. Department of Energy
Technical Information Center, P.O. Box 62
Oak Ridge, TN 37830

Instructional Module Contents:

1. Unit Outline (overhead)
2. Pre-Post Test (keyed)
3. Technical Glossary
4. Worksheet (vocabulary) - Word Decoding
5. Worksheet - DC Motors and Electric Generators
6. Quest Activity
7. Informational Handout (Operation of a Simple DC Motor)
8. Informational Handout (The Basics of DC and AC Generators)
9. Unit Module Answer Keys

XVI. Motors and Generators

- A. Method By Which Electrical Energy Can Be Converted Into Mechanical Energy

- B. Internal Construction of a Simple DC Motor

- C. Fundamental Motor Principles

- D. Servicing and Repair of Motors
  - 1. Causes of motor failures
    - a. Dirt

    - b. Moisture

    - c. Friction

    - d. Vibration

  - 2. General maintenance procedures

- E. Method By Which Mechanical Energy Can Be Converted Into Electrical Energy
  - 1. DC generators

  - 2. AC generators

F. Manner in Which Electricity is Generated and Distributed
   1. Power plant facilities
      a. Geothermal

      b. Fossil fuel
         1. Gas

         2. Oil

         3. Coal

      c. Hydro

      d. Nuclear

      e. Other (solar and wind)

   2. Distribution systems
      a. Transmission line

      b. Substation

Test Number _____

LII-U16

UNIT EXAM

IMPORTANT-

Indicate your responses on the answer sheet only. Fill in the box corresponding to the correct answer to each question - there is only one correct answer for each question.

1. A generator is used to convert electrical energy into mechanical or rotational energy. (T-F)

2. DC motors and DC generators are very similar in construction. (T-F)

3. The rotating electromagnet within a DC motor is called the field magnet. (T-F)

4. All electric motors operate by the principle of magnetic or electromagnetic attraction and repulsion. (T-F)

5. The armature windings of a DC motor are connected to the power source via a commutator and a set of brushes. (T-F)

6. At present, all the world's electric energy is produced by generators. (T-F)

7. Alternating current generators are also called amplifiers. (T-F)

8. Electric generators operate by the principle of electromagnetic induction. (T-F)

9. A generator will produce electricity using either a stationary magnetic field and a revolving coil, or by using a rotating magnetic field and a stationary coil. (T-F)

10. DC generators produce an electric current which flows first in one direction, stops and then flows in the opposite direction. (T-F)

11. Generally, an electric motor cannot be damaged by over oiling. (T-F)

12. Friction and dirt are a major cause of motor failure and overheating. (T-F)

13. Power plants are commonly operated using either fossil fuels, or hydro power. (T-F)

14. A substation provides a location where the electricity generated and shipped from the power plant can be switched, routed, and transformed as required. (T-F)

15. The "size" of an electric motor is given in terms of watts or horsepower. (T-F)

16. The small blocks of carbon which contact either the commutator or slip rings of a generator are called:
(A) brooms, (B) wipers, (C) rotors, (D) brushes.

17. The frequency of the AC power generated in most parts of the United States is:
(A) 50 hertz, (B) 55 hertz, (C) 60 hertz, (D) 120 hertz.

18. The rotor of an AC generator has a similar function to the __________ of a DC generator.
(A) field magnet, (B) armature, (C) commutator, (D) brushes.

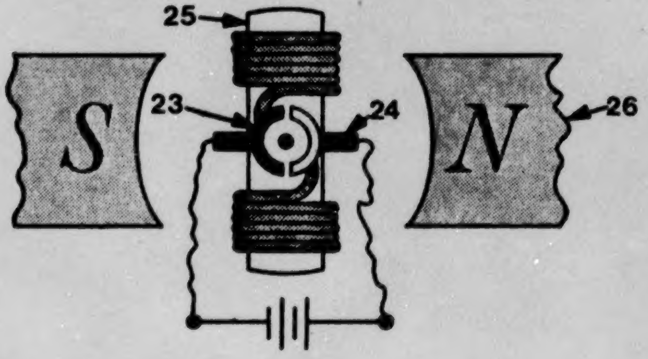
19. A DC motor will not contain a(n):
(A) brush set, (B) set of slip rings, (C) armature, (D) field magnet.

20. If the ends of an armature coil are connected to a set of slip rings, and the armature is rotated within a magnetic field:
(A) alternating current will be generated, (B) the voltage produced will change in both value and direction, (C) direct current will be generated, (D) both A and B.

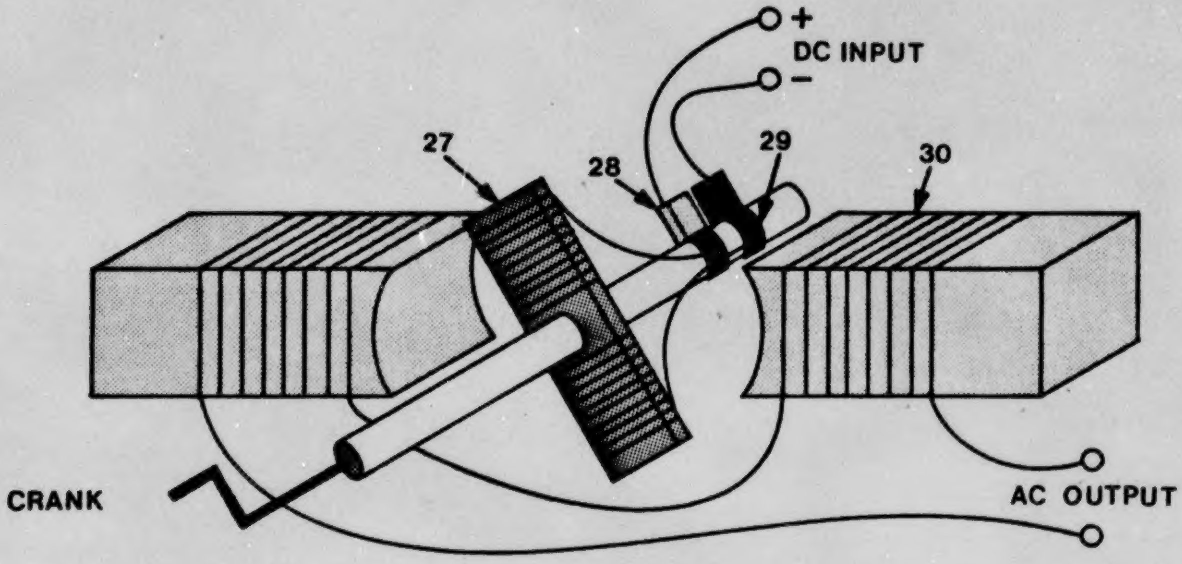
21. The armature of an electric motor rotates because it is both attracted and repelled from the poles of the field magnet. The device that controls the timing of the attracting and repelling force is called the: (A) timing switch, (B) commutator, (C) armature, (D) slip ring.

22. Large AC generators, such as those used in power plants, can be turned by:
(A) steam turbines, (B) diesel engines, (C) hydro turbines, (D) all of the above.

For questions 23 - 26 identify the parts of the DC motor pictured below.



For questions 27 - 30 identify the parts of the AC generator pictured below.

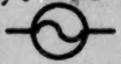
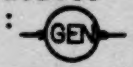


Name: ______________________

Date: ______________________

TECHNICAL GLOSSARY

Period: ______________________

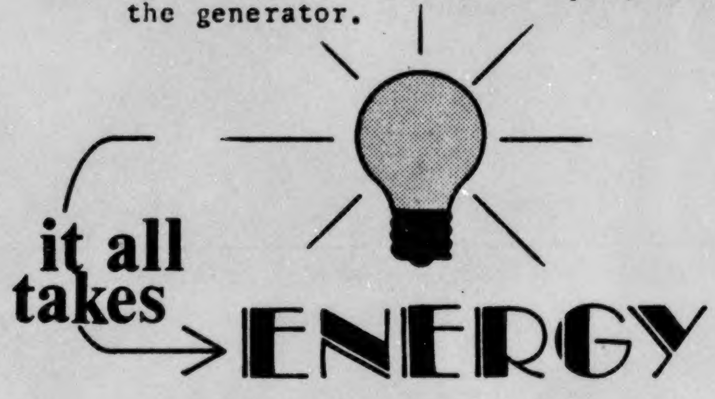
AC GENERATOR:	An electro-mechanical device which utilizes a revolving rotor, a stationary stator, and a slip ring brush set to produce AC electricity. AC generators are also called alternators. Symbol: 
ARMATURE:	The revolving part of a generator or motor. In a generator the voltage is produced within the coils of the armature. In a motor, the armature coils are attracted to and repelled from the field poles, causing motion.
BRUSHES:	A set of small conducting rods, usually carbon or copper which are used to make a sliding contact with the commutator or slip rings.
COMMUTATOR:	A ring of copper segments, insulated from each other, and used as part of the sliding contact between the brushes and the armature of a motor or generator.
DC GENERATOR:	An electro-mechanical device which utilizes a revolving armature, a stationary field magnet or electromagnet, and a commutator - brush set to produce DC electricity. Symbol:  GEN
DISTRIBUTION SYSTEM:	The power system which routes the electrical energy generated at the power plant to the consumer. The system includes; long distance transmission lines, step-down transformers, feeder lines, substation, distribution lines and distribution transformers.
FIELD MAGNET:	Either a permanent magnet or electromagnet used to provide the magnetic field required in a motor or generator.
FOSSIL FUEL:	Fuels such as coal, petroleum, natural gas, and refined petroleum products (gasoline, diesel oil, and fuel oil) which are burned in order to produce heat energy.
GEOTHERMAL:	A natural source of energy produced when water seeps into the ground, is heated by the earth's hot magma core, and then rises to the surface as steam. Geysers, steam vents, and fumaroles are examples of geothermal activity.
HORESEPOWER:	A method of rating the power or "strength" of a motor. One horsepower is equivalent to lifting 550 pounds, one foot, in one second.
HYDRO:	Refers to the energy provided by running or falling water.
MOTOR:	A machine that converts electric energy into mechanical or rotational energy. Motors utilize the magnetic forces of attraction and repulsion to cause an armature to rotate.

Name: ____________________

Date: ____________________

Period: ____________________

NUCLEAR:	A modern source of energy which uses the atomic principles of fission (the breaking of the atom) to produce tremendous amounts of heat. This heat is generally used to convert water into steam.
POWER PLANT:	A large generating facility used to produce the electric energy required by several cities or a section of the state. Power plants may use fossil fuels, hydro, nuclear, geothermal, or other energy sources to supply power to the turbines to turn generators which produce electricity.
ROTOR:	The rotating part of an AC generator or alternator. The rotor supplies a rotating magnetic field within the alternator.
SLIP RINGS:	Two copper rings which, along with the brushes, provide a sliding contact with the rotor of an alternator, or generator.
STATOR:	The stationary coils of an AC generator, in which voltage is produced.
SUBSTATION:	Part of an AC power distribution system where the high voltage energy from the transmission lines is changed to a usable voltage - current value. The substation includes transformers, switches, circuit breakers, and other equipment.
TRANSMISSION LINE:	The high tension power lines which are usually strung between steel towers, and carry the high voltage - low current AC energy from the power plant to the substation.
TURBINE:	A finned device, similar to the blades of a fan, which is connected to the rotor of the power plant generator. When steam or water is forced into the turbine blades, it causes the turbine to spin, thus turning the rotor of the generator.



SCORE:

GRADE:

Name: ______________

Date: ______________

Period: ______________

WORKSHEET

VOCABULARY WORD DECODING

The words below have little meaning until they are decoded. Each letter actually represents another letter in the alphabet. Your task is to break the code and decode each word. The example will get you started by providing four decoded letters. The code remains the same throughout the worksheet.

EXAMPLE:

A. D Y G Y V H S T A T O R	A. STATOR
1. C V Y V H – – – – –	1.
2. G H C G Y K H R – – – – – – – –	2.
3. Y K H M O N R – – – – – – –	3.
4. A V C C K Y G Y V H – – – – – – – – – –	4.
5. W R N R H G Y V H – – – – – – – – –	5.
6. W R V Y B R H C G I – – – – – – – – – –	6.
7. D K M D Y G Y O V N – – – – – – – – – –	7.
8. X O R I L C G W N R Y – – – – – – – – – – –	8.
9. M H K D B R D – – – – – – –	9.
10. Y H G N D C O D D O V N I O N R – – – – – – – – – – – – – – – –	10.

SCORE:

GRADE:

Name: ____________________

Date: ____________________

Period: ____________________

WORKSHEET

DC MOTORS AND ELECTRIC GENERATORS

1. A device which has the ability to change electrical energy into mechanical or rotational energy is called a __________. 1. ☐

2. A motor contains at least __________ interacting magnetic fields. 2. ☐

3. The armature in a motor rotates as a result of __________ attraction and repulsion. 3. ☐

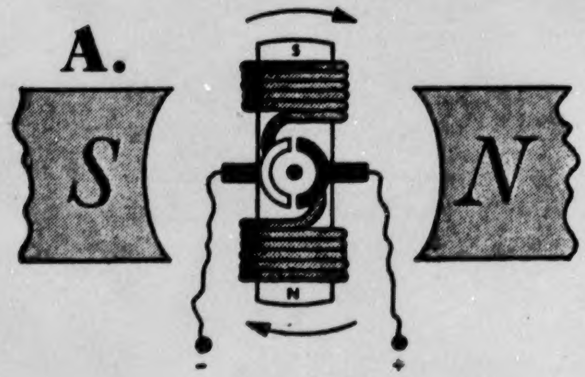
4. List the four basic parts of a DC motor.
4A. ☐
4B. ☐
4C. ☐
4D. ☐

5. The __________ and __________ form a rotating switch which controls the direction of current flow through the armature of a DC motor.
5A. ☐
5B. ☐

6. Explain what occurs when the current flow through the armature reverses in direction.

☐

7. Briefly describe the "motor action" occuring in the drawings below - pay particular attention to the location and effect of the commutator.



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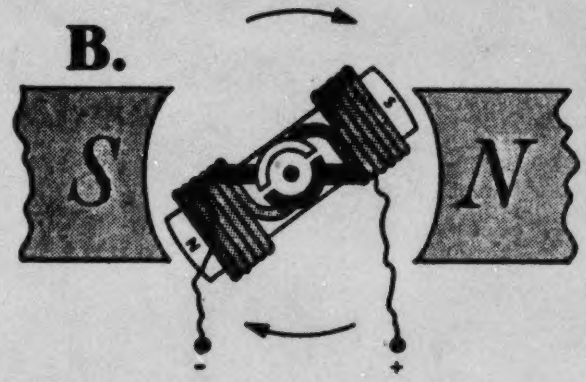
Name:

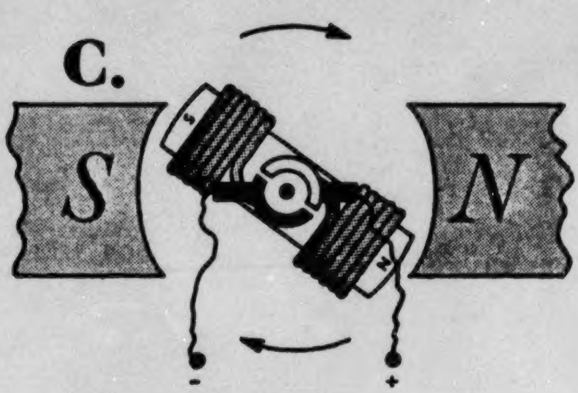
Date:

Period:

B.



C.



8. List four common causes of motor failure.

8A.

8B.

8C.

8D.

9. Explain why friction is so damaging to an electric motor and suggest a way friction can be reduced to an acceptable level.

10. What is the main physical difference between a simple AC and DC generator?

Name: ____________________

Date: ____________________

Period: ____________________

11. List the three basic requirements necessary to generate a voltage.

11A. ☐

11B. ☐

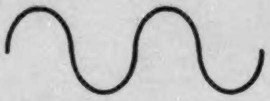
11C. ☐

12. Identify the generator output waves pictured below.

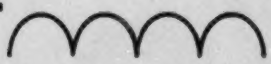
12A. ☐

12B. ☐

A.



B.



13. The __________ in the DC generator acts as a rotating switch, allowing the output current to flow in only one direction.

13. ☐

14. The A)__________ in an alternator will provide a strong electromagnetic field, which when rotated or turned, will generate a voltage in the stationary B)__________ windings.

14A. ☐

14B. ☐

15. Name three factors which will affect the output of a generator. In each case indicate how the output will be affected.

A. ☐

B. ☐

C. ☐

SCORE:

GRADE:

Name: ____________________

Date: ____________________

Period: ____________________

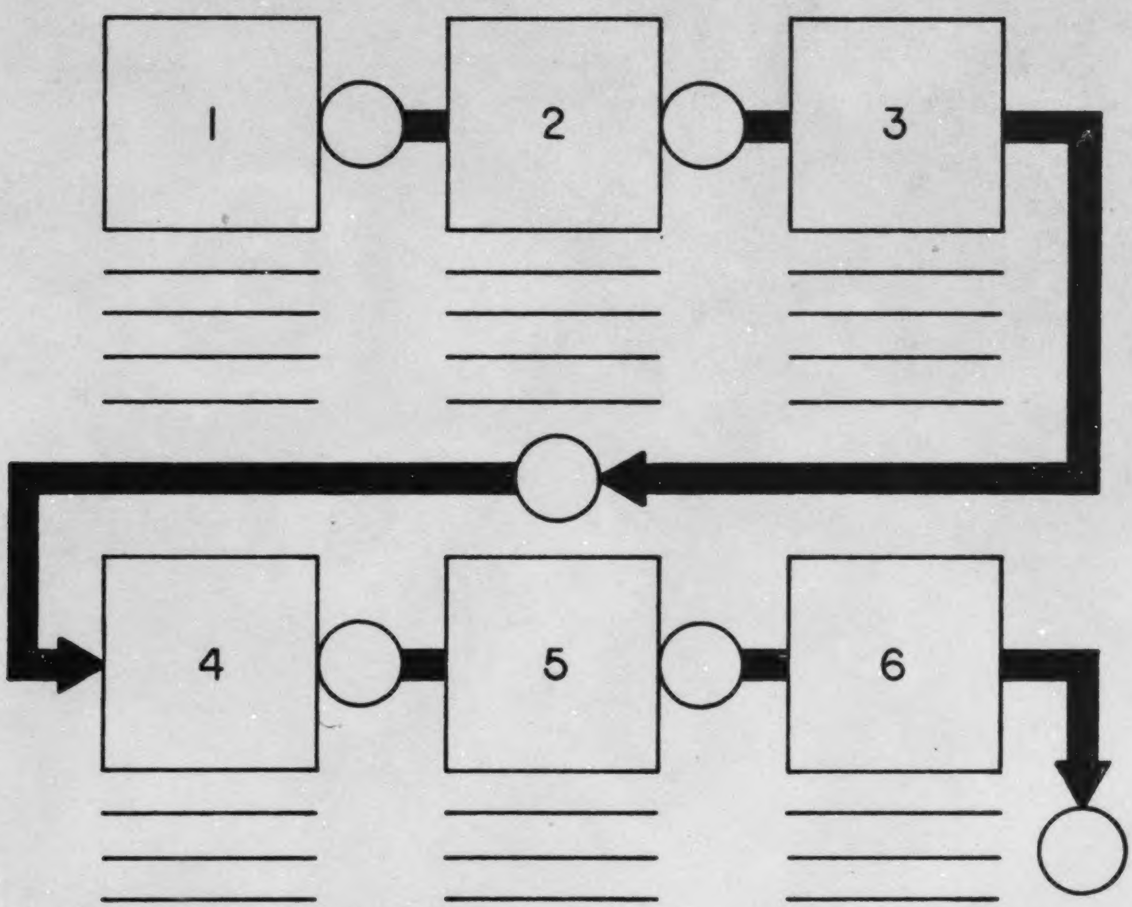
WORKSHEET

QUEST ACTIVITY

"UNIT 16"

Utilizing the appropriate "puppets" on the attached page, cut out and place each "puppet" element in proper sequence to form a complete AC Power Distribution System. In the circles to the right of each "puppet", insert the approximate voltage. Begin with the production point and conclude with the energy user. Remember, below each "puppet" write a brief description of what is happening at that specific location.

1.



2. **AC power systems** are needed to: (in detail) ____________________

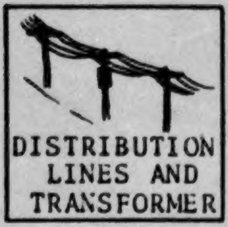
____

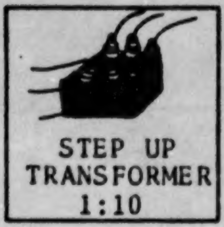
____

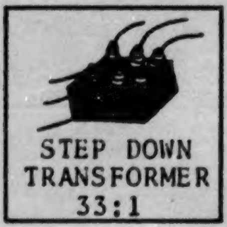
____

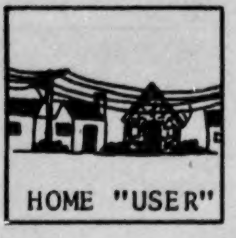
____

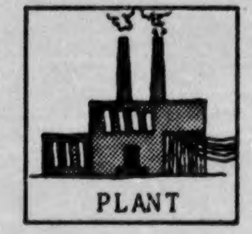
Puppets

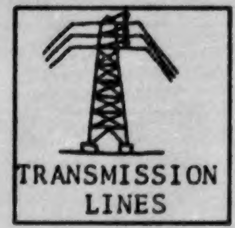

DISTRIBUTION
LINES AND
TRANSFORMER


STEP UP
TRANSFORMER
1:10


STEP DOWN
TRANSFORMER
33:1






TRANSMISSION
LINES

4,000 V

132,000 V

STOP

132,000 V

120/240 V

13,200 V

NOTE: Cut carefully around each puppet, use glue or tape to secure puppet to paper and be as neat as possible.

Name: ______________________

Date: ______________________

Period: ______________________

INFORMATIONAL HANDOUT

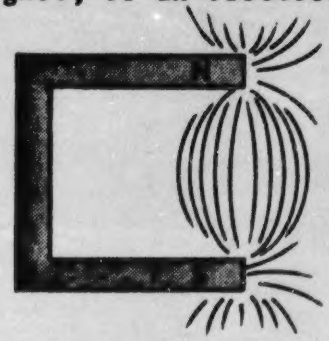
OPERATION OF A SIMPLE DC MOTOR

An electric motor is able to convert electrical energy into mechanical or rotational energy. The first crude electric motor was developed in 1831 by an American, Joseph Henry. Today electric motors are used in hundreds of home appliances and thousands of pieces of industrial equipment.

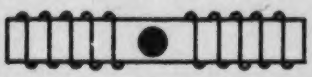
Basically, electric motors operate on the principle of magnetic repulsion and attraction - that is, like poles repel, and unlike poles attract. In its simplest form, a DC motor will contain two interacting magnetic fields, one stationary, and one which is able to rotate or revolve. These two interacting fields cause the motor to produce "torque", or rotational energy.

The basic parts of a DC motor are the:

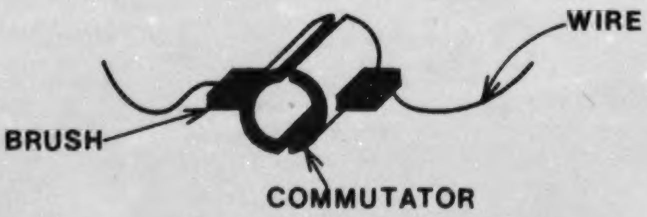
● Field magnet; a stationary magnetic field provided by either a permanent magnet, or an electromagnet.



▲ Armature; an electromagnet wound on a shaft or axle. The armature will revolve within the field magnet.



⬢ Commutator and Brushes; the commutator is made up of at least two segments of copper, which are insulated from each other, and are located on the armature shaft. Connected to each commutator segment is one end of the wire which makes up the armature coil. The brushes which are made of either carbon or copper, ride against the commutator, forming a rotating connection.

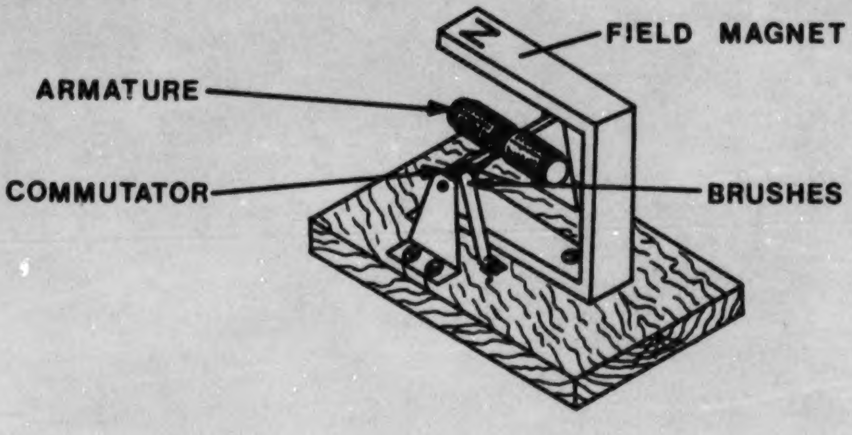


Name: ____________

Date: ____________

Period: ____________

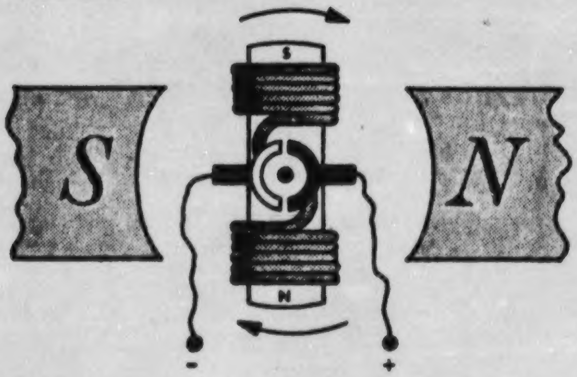
A SIMPLE DC MOTOR



HOW THE DC MOTOR WORKS

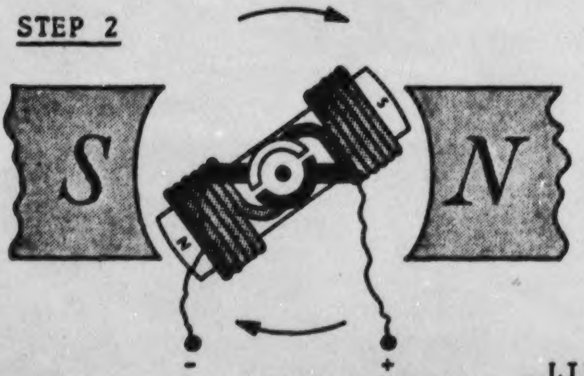
The key to the operation of a DC motor is the armature/commutator action. Recall, the armature is basically a coil of wire, which forms an electromagnet when current flows through it. The direction of current flow through the coil will determine the north and south poles of the electromagnet. The commutator and brushes, in turn, will route the current through the armature coils in the proper direction to cause the armature to be attracted to or repelled from the proper field pole at the proper time.

STEP 1



When a battery is connected to the brushes and commutator as shown, the armature coil produces a magnetic field having a south pole at the top of the coil, and a north pole at the bottom. In this case, the armature poles will be attracted toward the field magnet poles in a clockwise direction.

STEP 2



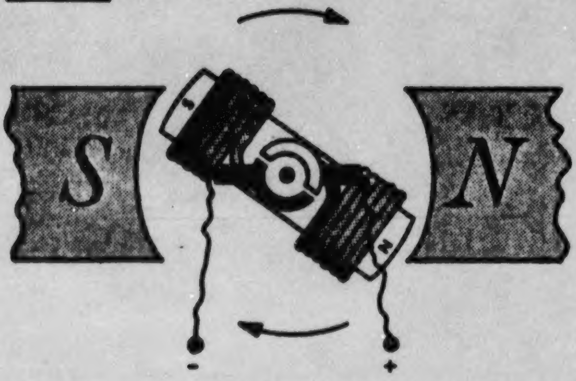
As the armature approaches the horizontal position its magnetic polarity must be changed in order to prevent the armature from being trapped by the strong field magnet's north pole and stopping. If you look closely at the commutator, you will notice that the brushes are approaching the gap between the commutator segments. Once the brushes contact the gap, the armature field is momentarily turned off, allowing it to rotate past the field poles.

Name: ____________________

Date: ____________________

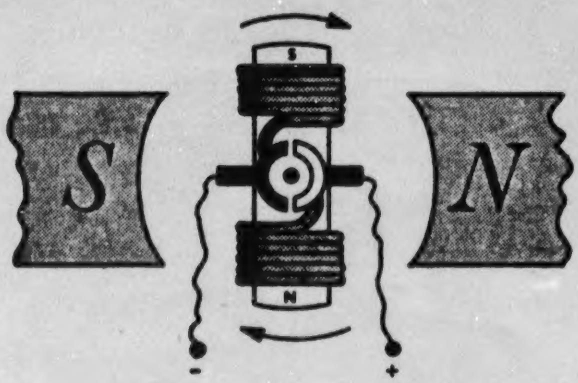
Period: ____________________

STEP 3



When the brushes touch the next commutator segment, (the positive brush is now contacting the segment formerly touched by the negative brush). The polarity of the armature is reversed. The poles of the armature are now repelled by the field magnet.

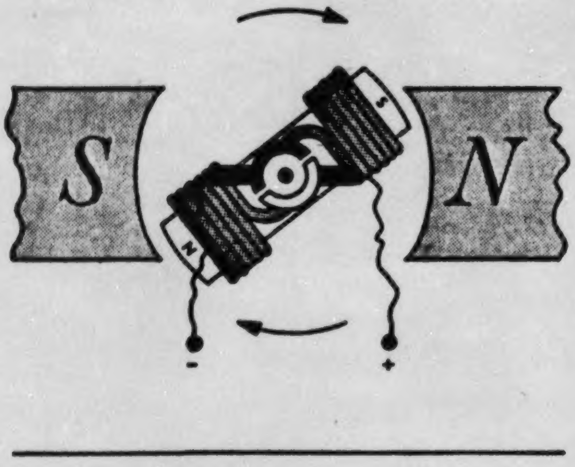
STEP 4



As the armature continues to rotate the armature's electromagnet and the field magnet begin to attract each other, and rotation continues.

See if you can complete the descriptions for steps 5 and 6 of the motors operation.

STEP 5

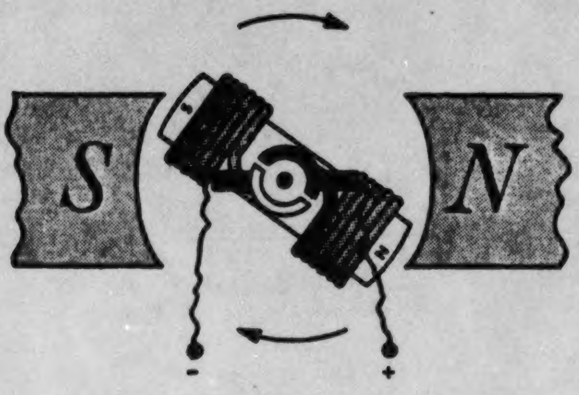


Name: ____________

Date: ____________

Period: ____________

STEP 6



____

____

____

____

____

Finally, the armature will return to its starting position as shown in step 1, completing one revolution.

ANSWERS:

Step 5.

Similar to description in Step 2.

Step 6. Similar to description in Step 3.

Name: ____________________

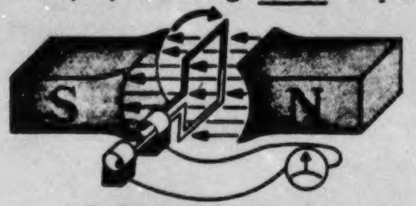
Date: ____________________

Period: ____________________

INFORMATIONAL HANDOUT

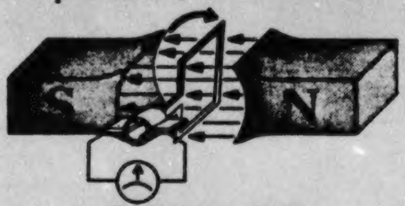
THE BASICS OF DC AND AC GENERATORS

Generators convert mechanical energy into electrical energy by a process known as electromagnetic induction; that is by either moving a coil of wire through a magnetic field, or by holding the coil stationary, and moving the magnetic field. DC generators produce pulses of electricity which always have the same polarity - either positive or negative; while AC generators produce pulses of electricity which periodically change "polarity", having both a positive and negative portion.



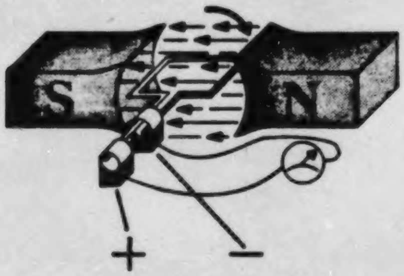
AC GENERATOR

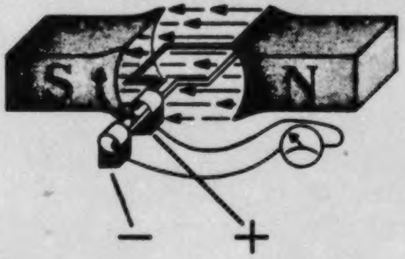
NOTE: Meter center is zero.



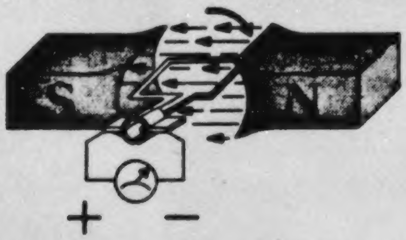
DC GENERATOR

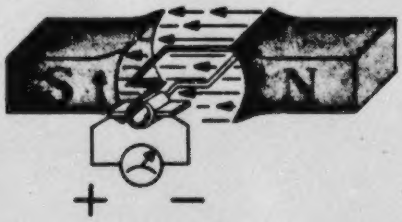
The difference between the two generators lies in the direction that the generated current is allowed to flow through the coil. In an AC generator (alternator), the ends of the coil loop are connected to a set of slip rings which permits current to flow first in one direction, (as the loop moves past the north field pole) and then to reverse, and flow in the opposite direction, (as the loop moves past the south field pole). Thus, the potential of the voltage present on the brushes changes first from + to - then from - to +.





The DC generator uses a commutator, instead of slip rings, as the end connection of the armature loop. The commutator causes the current to flow in only one direction from the coil. The half of the loop passing the north field pole will always produce one potential (negative), while the half of the loop which passes the south field pole will always produce the opposite potential (positive). Thus, the potential of the voltage present on the brushes is always the same - one positive, and one negative.





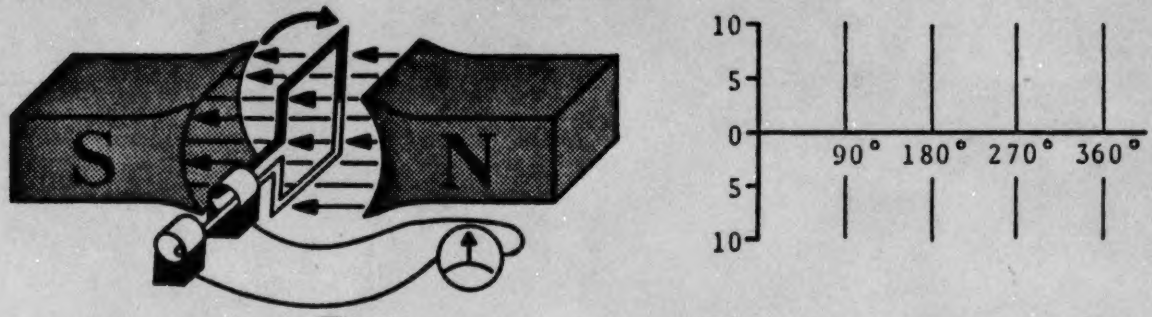
Name: ______________

Date: ______________

Period: ______________

AC AND DC GENERATION:

AC GENERATOR


S
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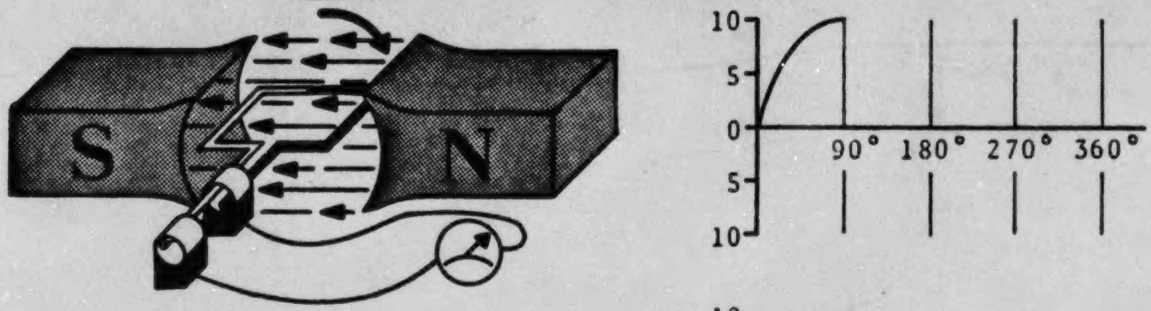
10
5
0
5
10
90°
180°
270°
360°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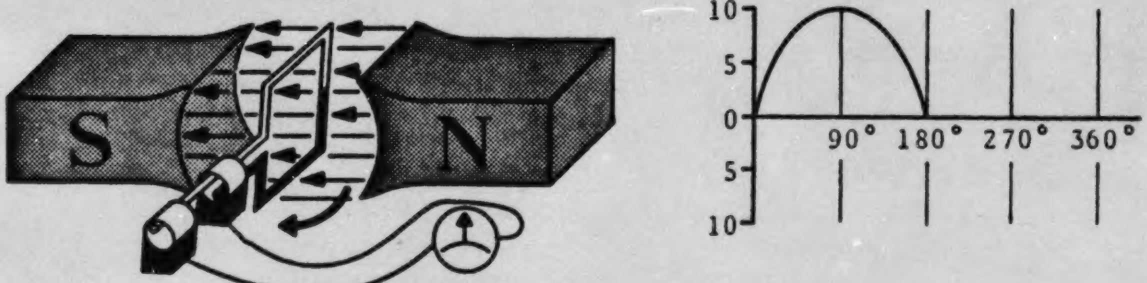
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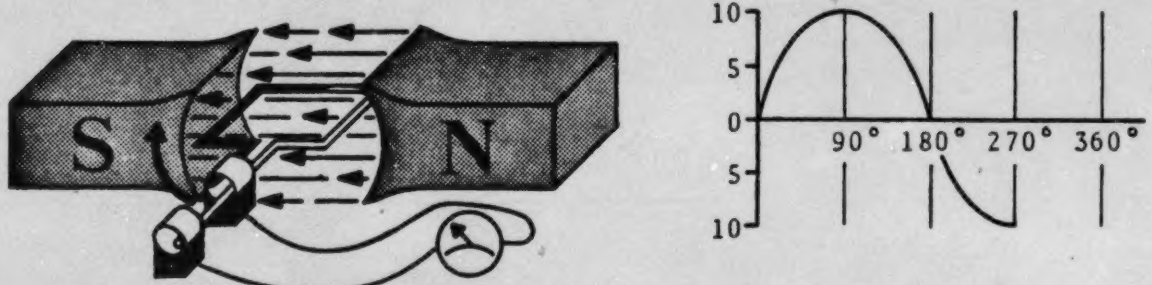
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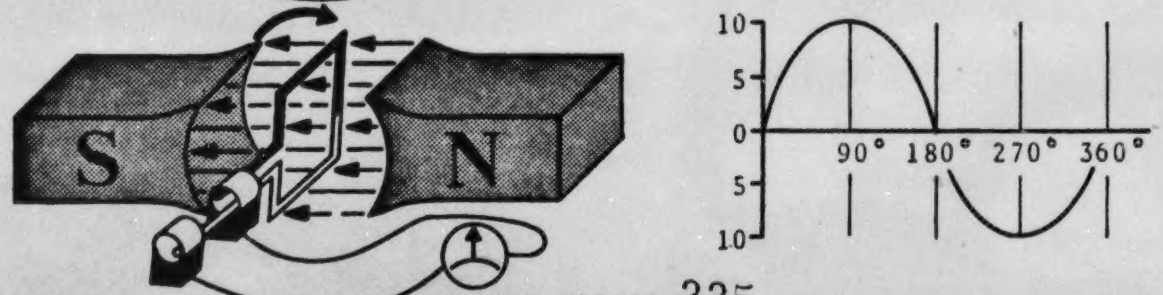
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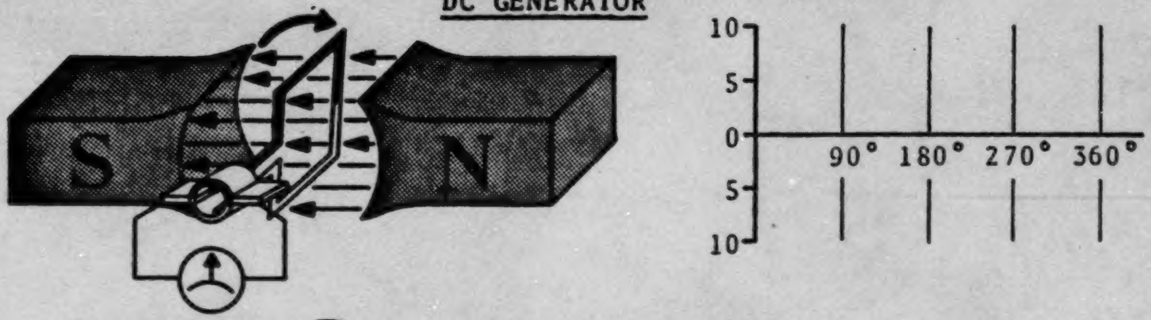
90°
180°
270°
360°

Name: ____________________

Date: ____________________

Period: ____________________

DC GENERATOR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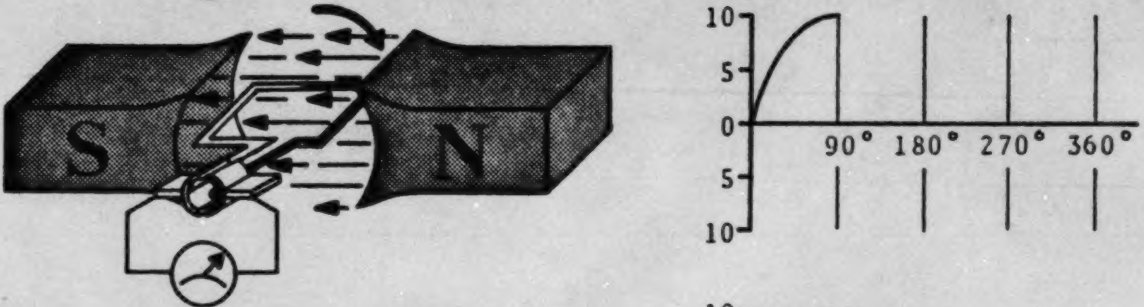
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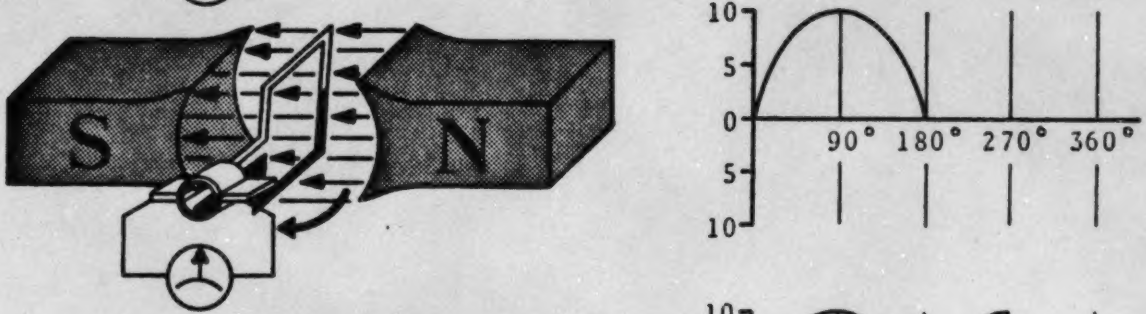
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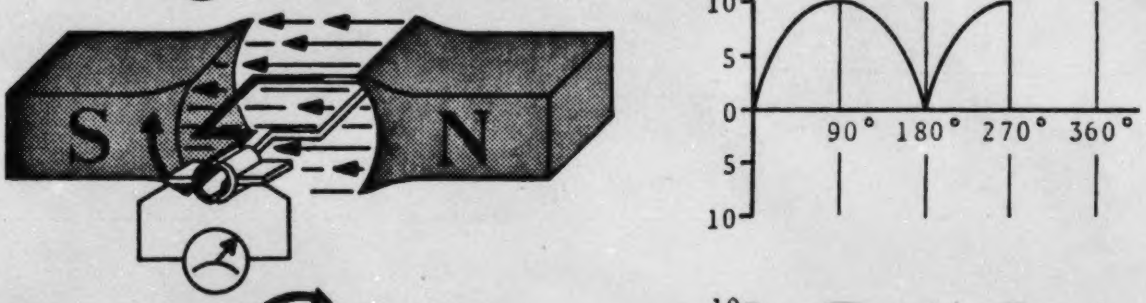
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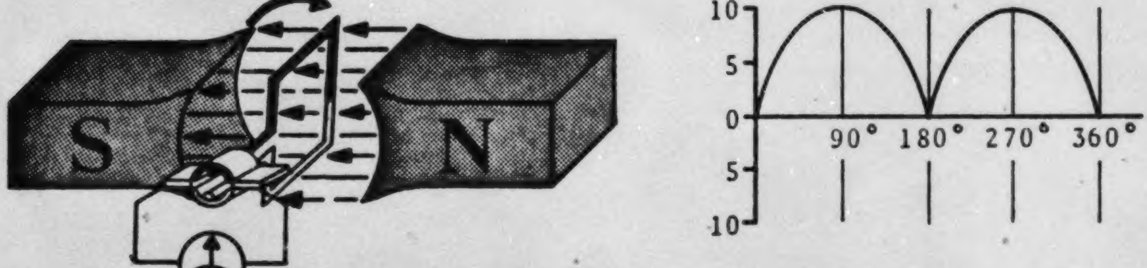
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90°
180°
270°
360°

SCORE:

GRADE:

Name:

Date:

Period:

ANSWER SHEET

EXAM LII-U16

	T A	F B	C	D		T A	F B	C	D		T A	F B	C	D		T A	F B	C	D
1.		■			26.	field pole				51.					76.				
2.	■				27.	rotor				52.					77.				
3.		■			28.	brush				53.					78.				
4.	■				29.	slip ring				54.					79.				
5.	■				30.	stator				55.					80.				
6.		■			31.					56.					81.				
7.		■			32.					57.					82.				
8.	■				33.					58.					83.				
9.	■				34.					59.					84.				
10.		■			35.					60.					85.				
11.		■			36.					61.					86.				
12.	■				37.					62.					87.				
13.	■				38.					63.					88.				
14.	■				39.					64.					89.				
15.	■				40.					65.					90.				
16.				■	41.					66.					91.				
17.			■		42.					67.					92.				
18.	■				43.					68.					93.				
19.		■			44.					69.					94.				
20.				■	45.					70.					95.				
21.		■			46.					71.					96.				
22.				■	47.					72.					97.				
23.	commutator				48.					73.					98.				
24.	brush				49.					74.					99.				
25.	armature				50.					75.					100.				

*Show work for problems on back of answer sheet.

ANSWER KEY
UNIT 16

A. WORD DECODING

1. motor
2. armature
3. turbine
4. commutator
5. generator
6. geothermal
7. substation
8. field magnet
9. brushes
10. transmission line

B. DC MOTORS & ELECTRICAL GENERATORS

1. motor
2. two
3. magnetic
4A. armature
4B. field magnet
4C. commutator
4D. brushes
5A. brushes
5B. commutator
6. The polarity of the armature is reversed and now the poles of the armature are repelled by the field magnets and the armature continues to rotate.
7. In figure A, current flow in the armature polarizes the armature as shown and the upper pole is repelled from the S. pole of the field magnet and is attracted toward the N. pole of the field magnet. The bottom of the armature is affected in the same manner.
In figure B, the clockwise rotation of the armature is bringing the splits between the two commutator segments under the brushes. The centrifugal force of rotation will carry the upper segment into contact with the right hand brush and the lower segment to the left hand brush thereby reversing the direction of current flow in the armature and magnetizing it in the direction shown in figure C. Now we have the same conditions we had at figure A and are ready to continue.
8A. worn brushes
8B. frozen or worn bearings
8C. shorted or open field or armature windings
8D. worn commutator
9. friction causes heat and heat will melt solder connections at the commutator or might short through the isolation between windings or melt a winding to cause an open circuit. Frequent cleaning and oiling.
10. A DC generator uses a commutator while an AC generator has slip rings.
11A. magnetic field
11B. conductor
11C. movement of the conductor in the field
12A. AC
12B. pulsing DC
13. commutator
14A. rotor
14B. stator
15 . speed increases voltage and frequency
15 . added magnetic poles higher voltage for less speed
15 . more armature windings - higher voltage for less speed
15 . stronger field - higher voltage
15 . slip rings will produce AC while commutator segments will produce DC

C. QUEST ACTIVITY

1. puppet - plant
2. puppet - step/up transformer
3. puppet - transmission lines
4. puppet - step down transformer
5. puppet - distribution lines
6. puppet - home "user"

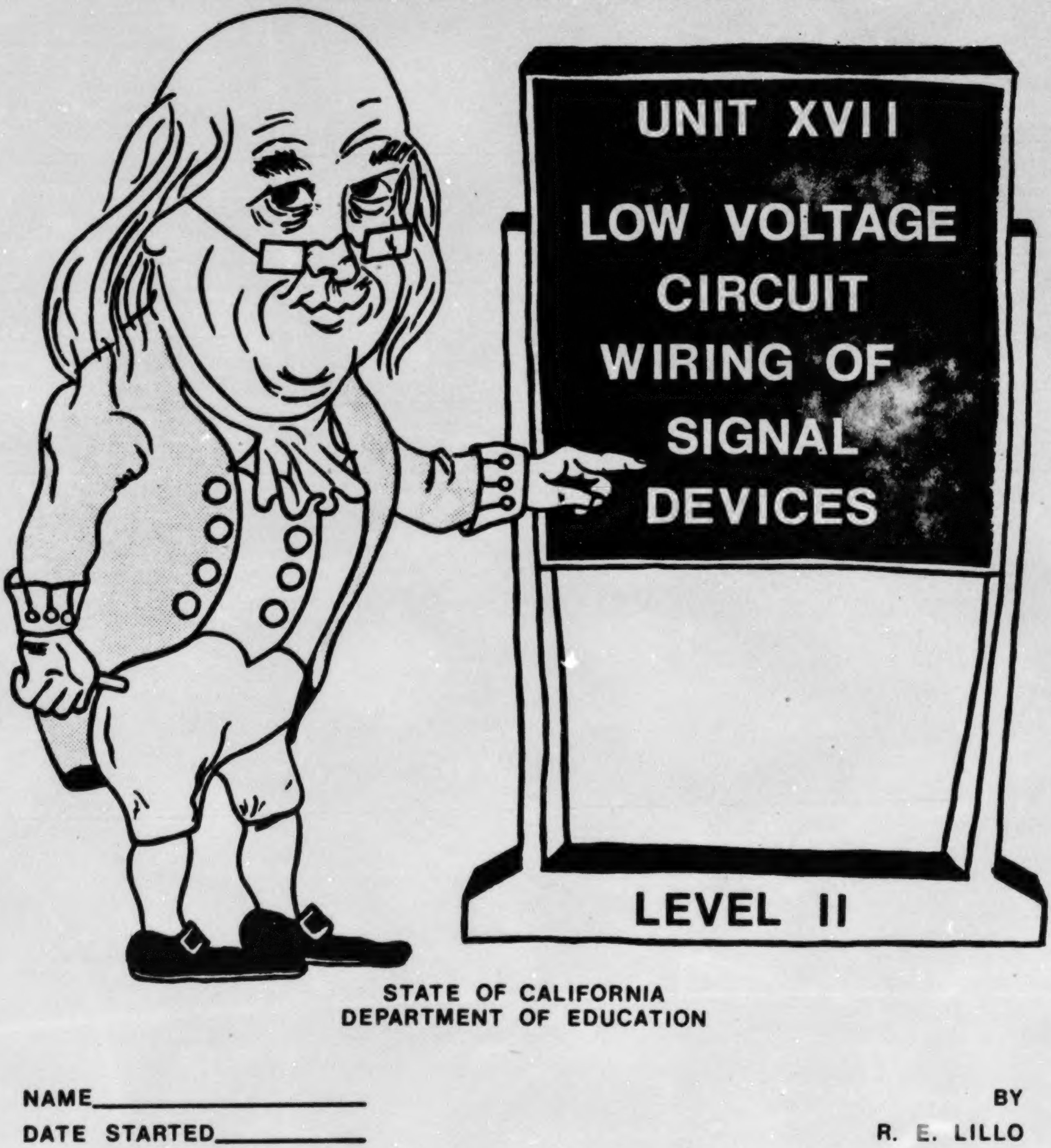
Circles

13,200
132,000
132,000
4,000
120/240
stop

2. (subjective evaluation)

ELECTRICITY / ELECTRONICS

CURRICULUM GUIDE
INSTRUCTIONAL MODULE



UNIT XVII

LOW VOLTAGE CIRCUIT WIRING OF SIGNAL DEVICES

LEVEL II

STATE OF CALIFORNIA
DEPARTMENT OF EDUCATION

NAME________________

DATE STARTED__________

DATE COMPLETED________

BY
R. E. LILLO
N. S. SOFFIOTTO

STATE ELECTRICITY/ELECTRONICS CURRICULUM GUIDE
INSTRUCTOR'S GUIDE TO ACCOMPANY LEVEL II UNIT # 17

Title of Unit: Low Voltage Circuit Wiring of Signal Devices

Time Allocation: 2 weeks

Unit Goal:

To bring about student competence in apprehending an overview of low voltage, low current circuits, including knowledge of the special techniques for wiring signal circuits, and a profile of basic security alarm systems.

Unit Objectives:

The student will be able to:

1. identify the five basic components required for a typical signal circuit: power source, bell transformer, push-button switch, wire, and a signal device.

2. demonstrate an ability to wire signal circuit components either in series, parallel, or in combination as directed.

3. distinguish between a signal type circuit and a power type circuit and explain the detection, control, and signaling operation of a typical security alarm system.

Evaluation:

The student will demonstrate his/her competence in terms of these measurable objectives based upon individual instructors acceptable performance criteria, which may utilize a combination of written, oral, and laboratory testing procedures.

Instructor References:

Industrial Arts Electricity. Clifford Lush and Glenn Engle, Chas. A. Bennet Co., 1971. Chapter: 2.

Industrial Electricity. Rex Miller, Chas. A. Bennett Co., 1978. Chapters: 11 and 16.

Introduction to Electricity. Kurt Harding Schick, McGraw-Hill Book Company Ryerson Limited, 1975. Chapters: 14 and 20.

Overview:

The primary purpose of this unit is to allow students the opportunity to scrutinize the reasons why signal circuits are treated differently from power circuits.

To attain this purpose, first introduce students to the essential ingredients that comprise a signal circuit. Second, modify signal device circuitry so that controls or bells are placed in series or parallel. This will broaden student technical understanding of typical variations in basic low voltage, low current circuits.

The final topic of this unit was included to generate enthusiasm and to be informative. Security alarm systems have emerged as a giant allied field to electronics and the practical application is an important competency to impart. Note: Carefully examine the activities in this unit, they are extremely exciting to students if presented in a positive manner. The exam in this unit is of a practical nature and will require more grading time.

Suggested Presentation Hints/Methodology:

Follow the instructional module unit outline as a basic skeleton for curriculum presentation, however, note the following:

1. Try to familiarize students with the applications of low voltage and low current systems in the home. Indicate that the telephone, doorbell, intercom, security alarm, antenna, smoke detector, etc. represent this type of system, and that generally, the wiring of these systems requires the knowledge of some special regulations as specified in the National Electrical Code.
2. Mention to the class that annunciators are used quite often in signal systems where many callers must wait for service or assistance, such as in hospitals. Hit upon the two main functions of such devices: it signals when activated, and it indicates where the signal was originated. These systems also have a means to reset thereby returning the unit to its normal static position.
3. When discussing security alarm systems and the techniques of providing burglar protection, have students examine some floor plans to determine vulnerable entry points. Have them "think like a burglar" and check the premises from this viewpoint. Once they have analyzed the situation in this manner, they are ready to develop an alarm system that could realistically foil the would be intruder.

Supplemental Activities and Demonstrations:

1. An activity with bells, switches, etc., that can promote student comprehension and challenge their imagination involves two phases. First, handout a simple floor plan of a rural school with three rooms. The problem is for them to draw in the wiring that will allow each room to have its own bell, however, all bells are to be controlled by one central switch. Second phase involves contructions of the student's bell circuit which now can be wired and tested on a "mock-up" type board.
2. While working in this unit, indicate to students that the wiring of signal circuits is generally accomplished by electricians. An occupational description of this specific occupation is very helpful and informative for students.

Instructional Module Contents:

1. Unit Outline (overhead)
2. Pre-Post Test (keyed)
3. Technical Glossary
4. Worksheet (vocabulary) - Spelling Puzzle
5. Worksheet - Parallel, and Combination Circuit Wiring of Signal Devices
6. Quest Activity
7. Informational Handout (Home Security Systems)
8. Unit Module Answer Keys

XVII. Low Voltage Circuit Wiring of Signal Devices

A. Signal Circuit Description
   1. Bell transformer

   2. Conductor

   3. Push-button switch

   4. Signal device

B. Signal Circuit Applications
   1. Basic series circuitry

   2. Basic parallel circuitry

   3. Combination circuitry

C. Security Alarm Devices
   1. Operation

   2. Installation

   3. Varieties

Test Number _____

LII-U17

UNIT EXAM

IMPORTANT-

Record your answers on this exam paper only. When answering the matching problems, record the letter corresponding to your choice.

MATCHING:

1. A device used to change 117V AC to 6V or 12V AC.
2. A circuit which contains more than one path for current flow.
3. A material which allows free movement or flow of electrons.
4. A noise making device such as a bell or siren.
5. The "sensing" device in an alarm system.
6. A type of switch which is activated only as long as pressure is applied.
7. A circuit which contains only one path for current flow.
8. The "brain" or central unit of an alarm system.
9. A type of alarm sensor which projects an invisible field of electrical waves.
10. A circuit which contains both series and parallel sections.

A. Series
B. Control unit
C. Conductor
D. Parallel
E. Signal device
F. Ultrasonic
G. Compound
H. Light beam
I. Toggle
J. Combination
K. Loop
L. Bell transformer
M. Detector
N. Push-button
O. Processor

1. ☐
2. ☐
3. ☐
4. ☐
5. ☐
6. ☐
7. ☐
8. ☐
9. ☐
10. ☐

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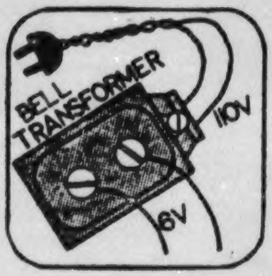
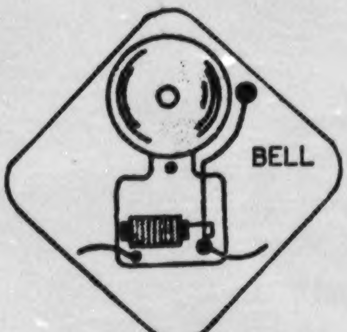
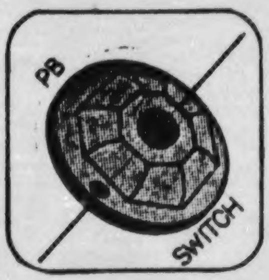
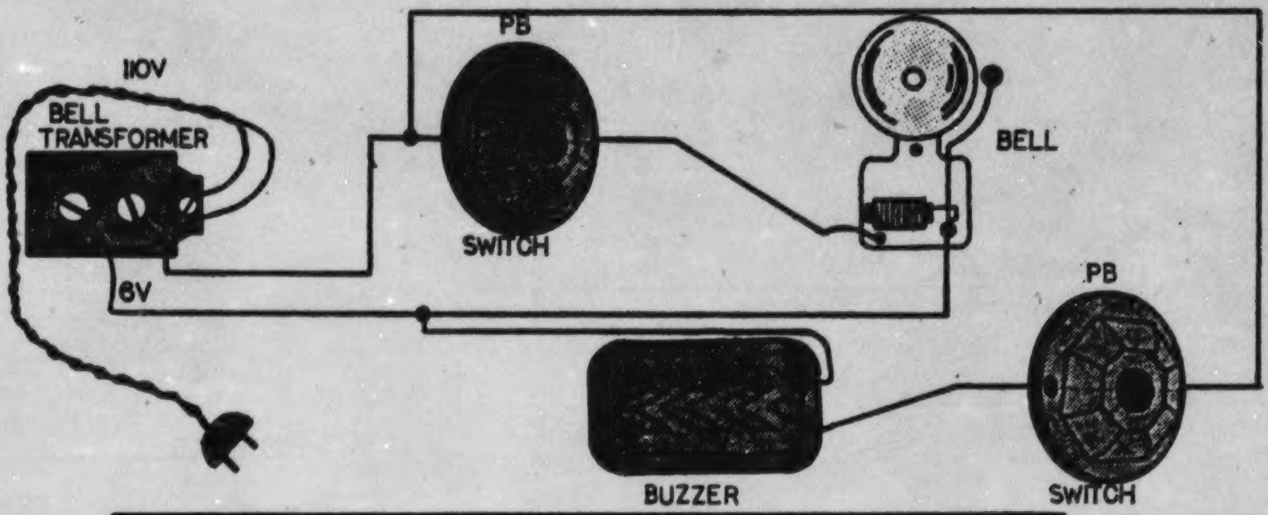
11. Connect the signal circuit components below into a series circuit.







12. Draw the schematic diagram which corresponds to the circuit pictured below.


110V
BELL TRANSFORMER
6V
PB
SWITCH
BELL
PB
BUZZER
SWITCH

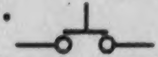
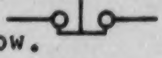
Answer Box

Name: ____________________

Date: ____________________

Period: ____________________

TECHNICAL GLOSSARY

ALARM CONTROL UNIT:	The "brain" or central unit in an alarm system. The control monitors the various detectors in the system and activates the alarm or signal device if the protection circuit is interrupted or violated. The control often contains an on/off switch, status indicators, time delays, power supplies, and stand by batteries.
ALARM DETECTOR:	The part of an alarm system which senses entry or movement in the protected area. The simplest detector is a switch; other common detectors are magnetic switches, pressure sensors, light beams, etc.
BELL TRANSFORMER:	A small transformer, with built-in overload and short protection, which will convert 117V to 6 or 12 volts for the operation of door bells, buzzers, or chimes.
COMBINATION CIRCUIT:	A circuit consisting of one or more series and parallel paths.
CONDUCTOR:	Any material through which electric current flows easily, such as a piece of copper wire.
LIGHT BEAM ALARM:	A common type of alarm or signaling circuit which will cause a signal device to sound if the light beam is broken.
PARALLEL CIRCUIT:	A circuit which provides two or more paths for current flow, sometimes referred to as a shunt or branch circuit.
PUSH-BUTTON SWITCH:	A spring loaded switch which is activated only as long as the push button is held in the down position. There are basically two types of P.B. switches - normally open and normally closed. Symbols: P.B.N.O.  P.B.N.C. 
SERIES CIRCUIT:	A circuit which has only one path for current flow. Series circuit components are connected in a line, one after the other.
SIGNAL DEVICE:	Generally a noise making device used to alert, notify, or gain your attention. Common signal devices are bells, buzzers, horns, or sirens.
ULTRASONIC ALARM:	A "motion detector" alarm which sets up an invisible field of electrical waves. If the wave pattern is disturbed or interrupted by movement of any kind, the alarm will be triggered.

SCORE:

GRADE:

Name: ____________________

Date: ____________________

Period: ____________________

WORKSHEET

VOCABULARY - SPELLING PUZZLE

Identify the correct spelling for the words listed below.

A. (example) (exhample) (xample) A. EXAMPLE

1. (cuntrol) (controll) (control) 1. ____

2. (circuit) (circut) (sircut) 2. ____

3. (beem) (beam) (beme) 3. ____

4. (allarm) (alarm) (elarm) 4. ____

5. (siginal) (signel) (signal) 5. ____

6. (switch) (swich) (swetch) 6. ____

7. (divice) (device) (devise) 7. ____

8. (ditectar) (detecter) (detector) 8. ____

9. (conducter) (kinducter) (conductor) 9. ____

10. (ceries) (series) (siries) 10. ____

11. (parallel) (parrallel) (parelel) 11. ____

12. (tranformer) (transformar) (transformer) 12. ____

13. (lito) (light) (liht) 13. ____

14. (combenation) (combinasion) (combination) 14. ____

15. (ultrasonic) (ultresonic) (ultrasonik) 15. ____

SCORE:

GRADE:

Name: ____________

Date: ____________

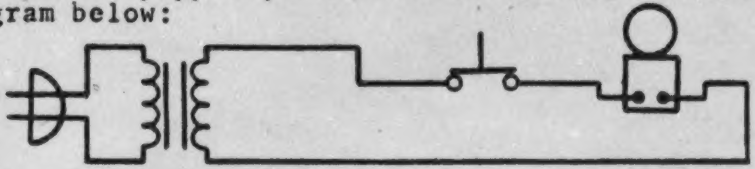
Period: ____________

WORKSHEET

SERIES, PARALLEL, AND COMBINATION CIRCUIT WIRING OF SIGNAL DEVICES

Utilize the puppets provided on page 3 to construct the circuits described below. You will cut out and arrange the puppets to form series, parallel, and combination circuits. You must draw in interconnecting lines to represent the conductors. Be sure that each problem fulfills the four requirements for a complete electric circuit -- i.e. supply, control, load, and conductor.

1. Using the appropriate puppets, assemble the circuit described in the schematic diagram below:



2. Is the circuit in question "1" a series, parallel, or combination circuit? 2. ____________

3. Design a buzzer circuit, which utilizes a 110V source, a bell transformer, and two push-button switches. Wire the circuit in such a way that pushing either switch will cause the buzzer to sound. Label the switches as a front door switch and a back door switch.

Name: ______________

Date: ______________

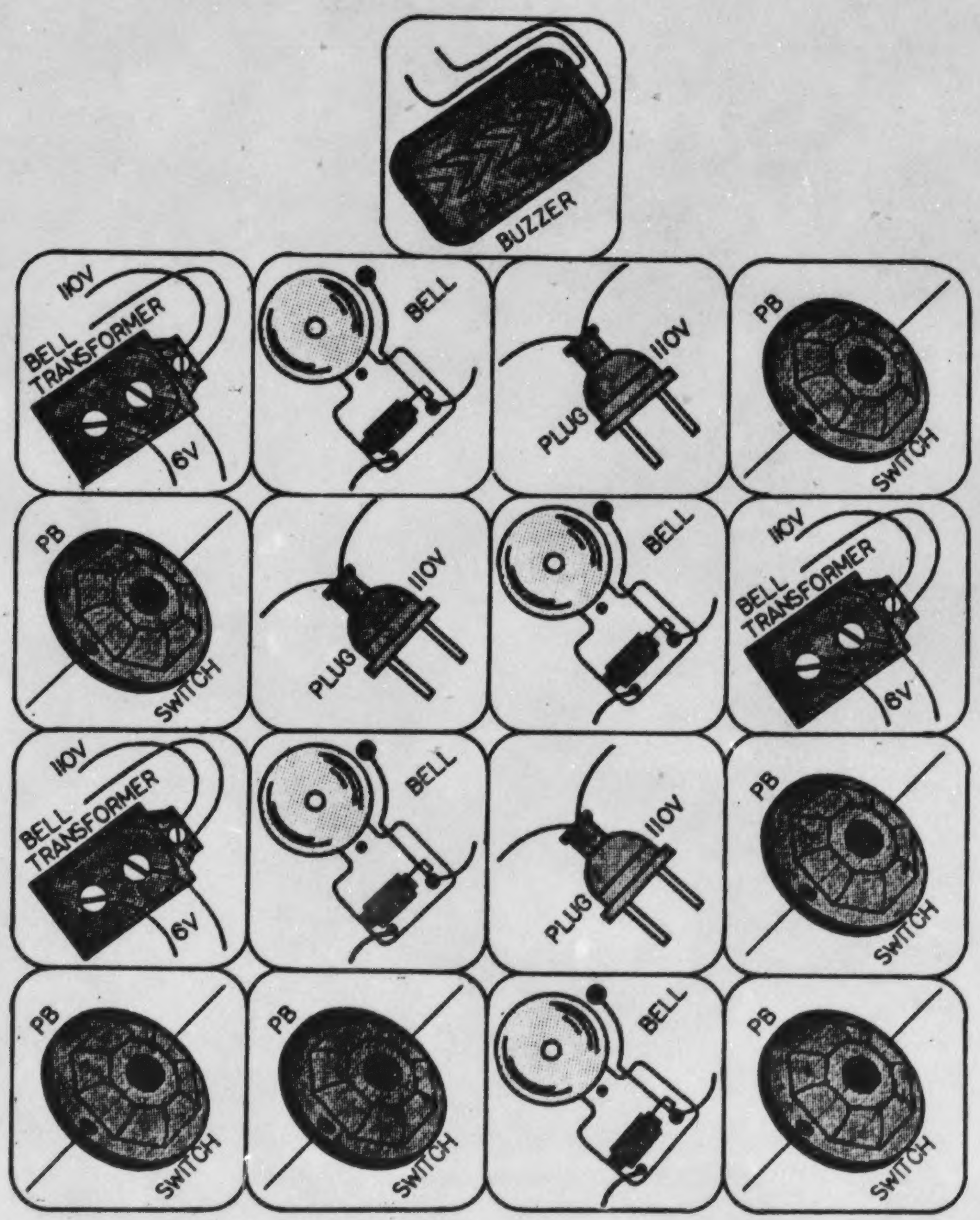
Period: ______________

4. Would the switching circuit you built in question "3" be considered a series, parallel, or combination circuit?

4. ☐

5. Design a combination circuit having one series and one parallel switching branch. Use 3 switches, 2 bells, 1 bell transformer, and a 110V source. If any one of the switches is pressed, a bell must sound.

Puppet Components


BUZZER
110V
BELL TRANSFORMER
6V
BELL
PLUG
110V
PB
SWITCH
PB
SWITCH
PLUG
110V
BELL
110V
BELL TRANSFORMER
6V
110V
BELL TRANSFORMER
6V
BELL
PLUG
110V
PB
SWITCH
PB
SWITCH
PB
SWITCH
BELL
PB
SWITCH

SCORE:

GRADE:

Name: ______________________

Date: ______________________

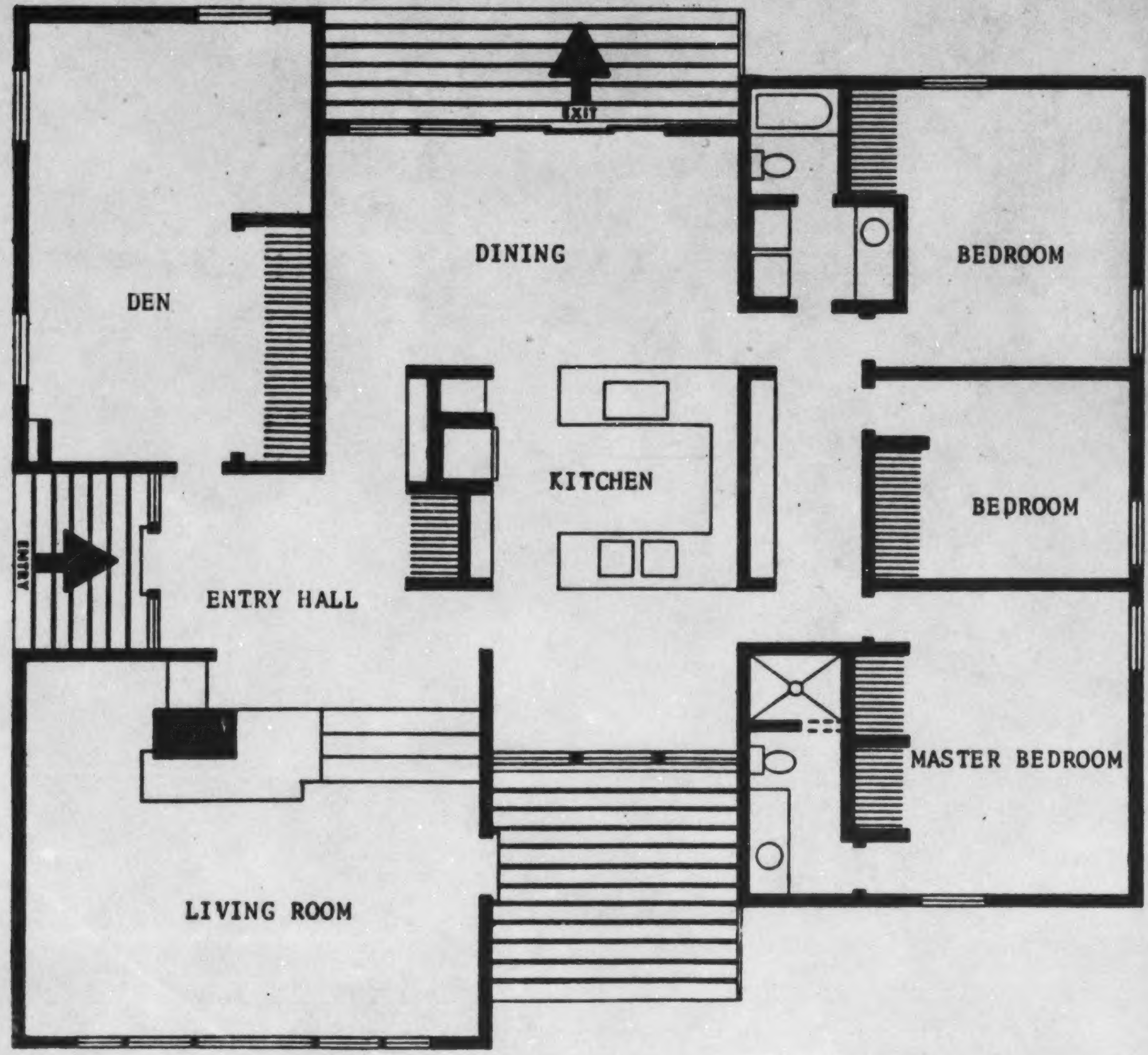
Period: ______________________

WORKSHEET

QUEST ACTIVITY

"UNIT 17"

Design a security alarm system for the house pictured below. You should include a control unit, various types of detectors, and one or more signal devices. Be imaginative, see if you can design a burglar proof system. Sketch in, and label the individual parts used in your security network, use single lines to represent the interconnecting wires needed to "tie" the various parts together. (Hint: use an alarm supply co. catalog or electronics supply house catalog to locate information on alarm products).


EXIT
DEN
DINING
BEDROOM
KITCHEN
BEDROOM
ENTRY
ENTRY HALL
MASTER BEDROOM
LIVING ROOM

Name: ____________________

Date: ____________________

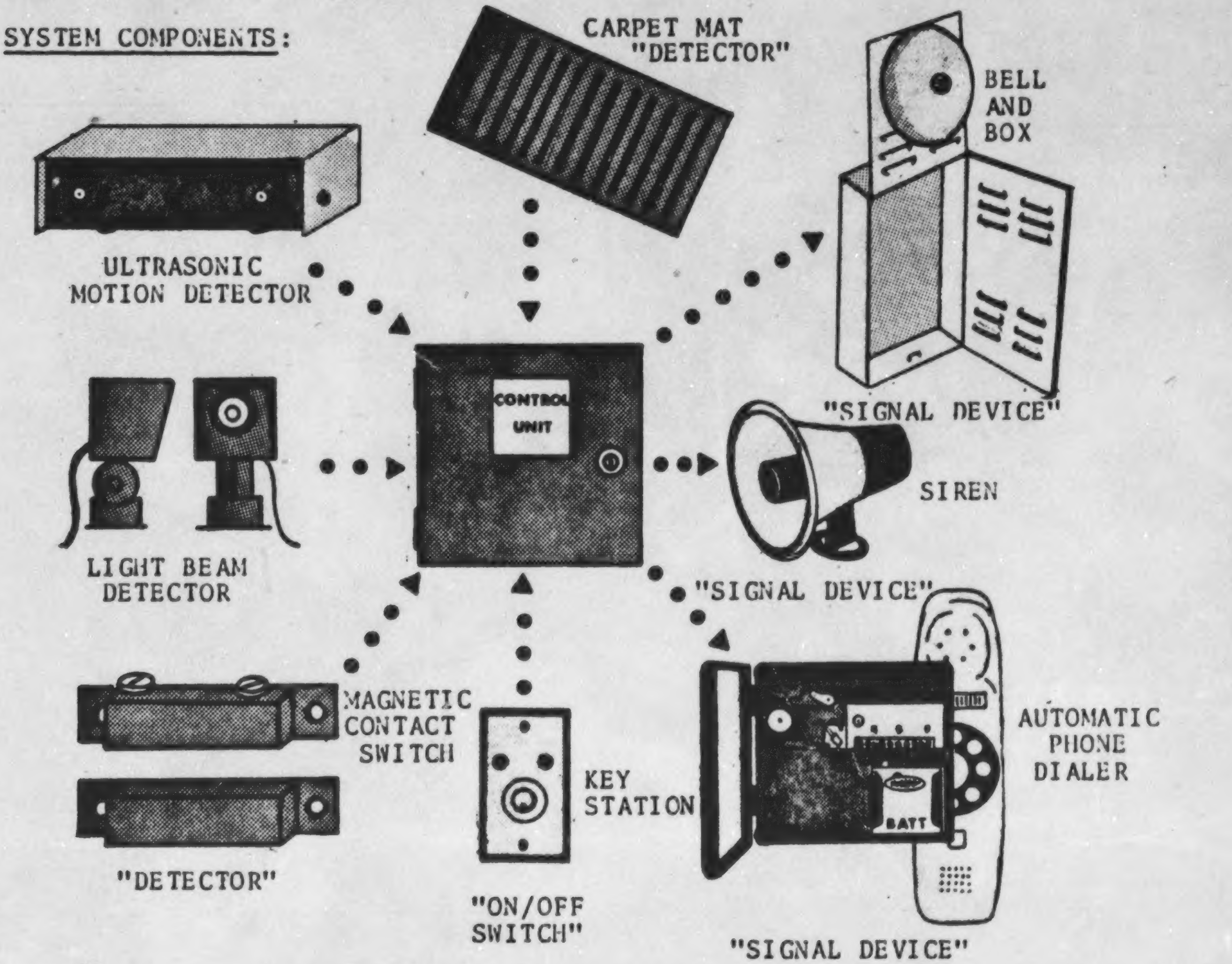
Period: ____________________

INFORMATIONAL HANDOUT

HOME SECURITY SYSTEMS

All burglar alarm systems have three common functions - detection, control, and signaling. The total system may be built into one box, or be made up of many separate pieces connected together with wire. "Detectors" are used to sense entry or movement within a protected area, and are basically switches or relays which operate by movement, pressure, or beam interruption. The "control unit" monitors the various detectors in the system, and triggers an alarm or signal device if the protection circuit sensor is interrupted or violated. The control unit also may contain on/off - power switches, test meters or status indicators, time delays, power supplies, stand by batteries, and terminals or lugs for wiring the system together. Finally, the signal device, usually a noise making bell or siren, is used to alert or notify you, your neighbor, or the police, that a break-in has occurred.

SYSTEM COMPONENTS:


CARPET MAT
"DETECTOR"
BELL
AND
BOX
ULTRASONIC
MOTION DETECTOR
CONTROL
UNIT
"SIGNAL DEVICE"
LIGHT BEAM
DETECTOR
SIREN
"SIGNAL DEVICE"
MAGNETIC
CONTACT
SWITCH
KEY
STATION
AUTOMATIC
PHONE
DIALER
BATT
"DETECTOR"
"ON/OFF
SWITCH"
"SIGNAL DEVICE"

ANSWER KEY
UNIT 17

A. EXAM

1. L
2. D
3. C
4. E
5. M
6. N
7. A
8. B
9. F
10. J
11. (subjective answer)
12. (subjective answer)

B. SPELLING PUZZLE

1. control
2. circuit
3. beam
4. alarm
5. signal
6. switch
7. device
8. detector
9. conductor
10. series
11. parallel
12. transformer
13. light
14. combination
15. ultrasonic

C. SERIES-PARALLEL-COMBINATION CIRCUIT WIRING OF SIGNAL DEVICES

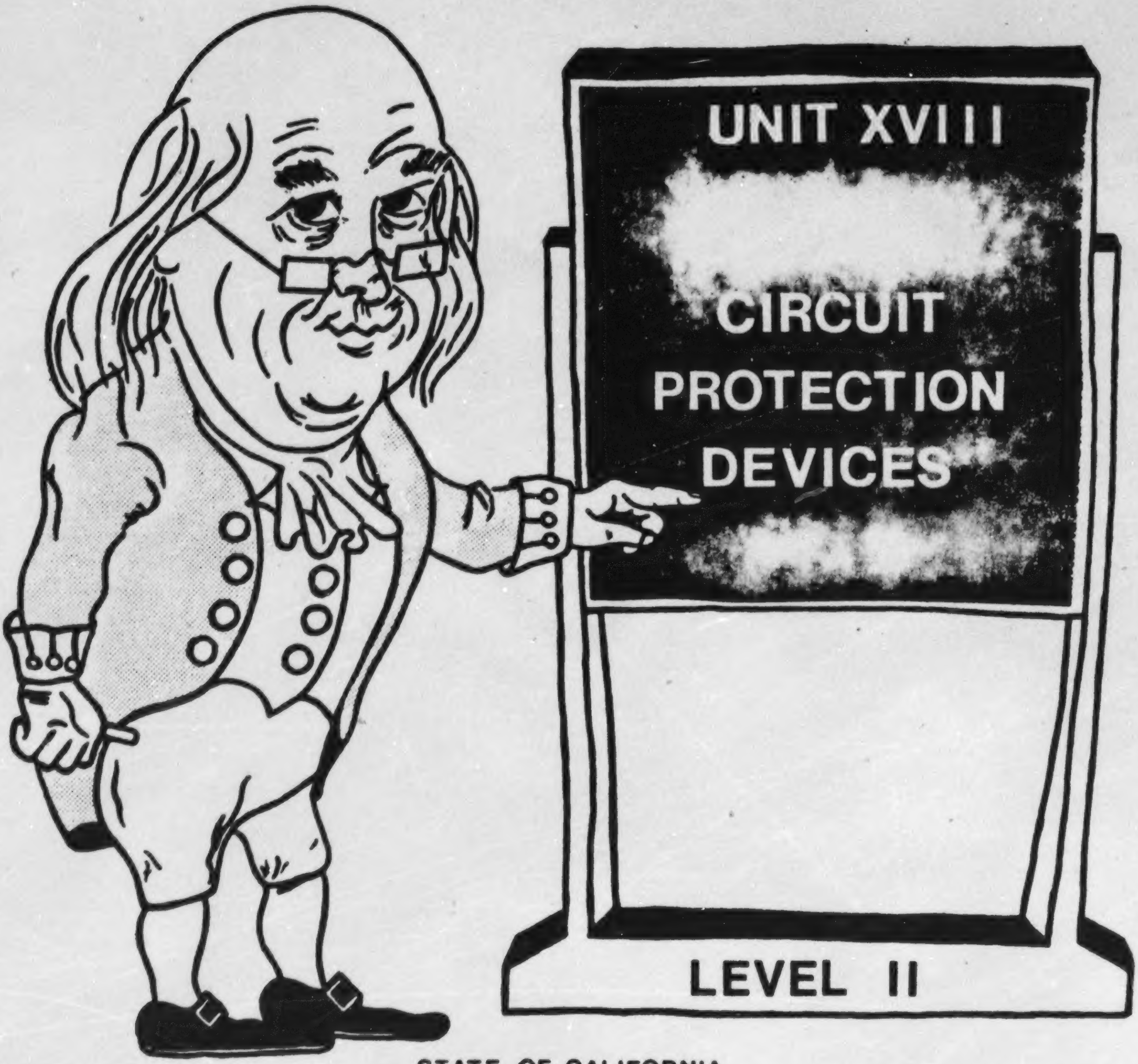
1. see diagram
2. series
3. (subjective answer)
4. parallel
5. (subjective answer)

D. QUEST ACTIVITY

(subjective evaluation)

ELECTRICITY / ELECTRONICS

CURRICULUM GUIDE
INSTRUCTIONAL MODULE


UNIT XVIII
CIRCUIT PROTECTION DEVICES
LEVEL II

STATE OF CALIFORNIA
DEPARTMENT OF EDUCATION

NAME____________________
DATE STARTED____________
DATE COMPLETED_________

BY
R. E. LILLO
N. S. SOFFIOTTO

Title of Unit: Circuit Protection Devices

Time Allocation: 1 week

Unit Goal:

To acquaint students with the general characteristics and electrical properties of circuit protective devices, thus aiding student comprehension of the common methods for insuring that a circuit operates only within its designed limits.

Unit Objectives:

The student will be able to:

1. describe the major need for protective devices in circuits and/or equipment, and identify two typical types of protective devices which may be employed.
2. demonstrate the proper technique for wiring protective devices into an electrical circuit.
3. troubleshoot a simple electrical circuit in order to identify the problem which may have caused a protective device to disable the circuit or equipment being investigated.

Evaluation:

The student will demonstrate his/her competence in terms of these measurable objectives based upon individual instructors acceptable performance criteria, which may utilize a combination of written, oral, and laboratory testing procedures.

Instructor References:

Industrial Electricity. Rex Miller, Chas. A. Bennett Co., 1978. Chapters: 5 and 9.

Introduction to Electricity. Kurt Harding Schick, McGraw-Hill Ryerson Limited, 1975. Chapter: 12.

Small Appliance Repairs. Robert W. Newnham, McGraw-Hill Book Co., 1967. Chapter: 11.

Overview:

Unit 18 concerns itself, specifically with the need and means for protecting electrical circuits, yet, it should not be overlooked that this topic has tremendous impact on a wide array of related technical consumer applications.

The unit should be introduced by examining a variety of circuit failure conditions or problems including overload. A brief description should ensue in terms of safety, causes of circuit failure, and methods for protecting a circuit.

Next, present an overview on the operation of several common circuit protection devices with emphasis on the techniques for wiring them into an electrical circuit. Finally, share with students some procedures that can be used to successfully troubleshoot a disabled circuit, include a demonstration of several maintenance steps that may help prevent an abnormal condition from surfacing within the protective device itself.

Suggested Presentation Hints/Methodology:

Follow the instructional unit module outline as a basic skeleton for curriculum presentation, however, note the following:

1. When discussing types (fast, or slow blow) or kinds (plug, cartridge, knife-blade, etc.) of specific circuit protection devices it is advantageous to either pass them around or utilize an opaque/overhead projector to help familiarize students with their physical appearance. Inform students of the relationship between the physical size of the device and its electrical rating.
2. The topic of circuit breakers can be approached by first explaining the three basic types: thermal breakers, electromagnetic breakers, and thermal-electromagnetic breakers. Define each variety and emphasize to students that they are typically used for feeder and branch-circuit protection in home electrical systems. Indicate that the ampere rating (size) of a breaker, always marked on the breaker lever, corresponds to the current carrying capacity of the wire being protected.
3. Remind students that it is extremely "dangerous" to tamper with a protective device. Give examples of what can occur if a fuse is intentionally by-passed or if a larger value fuse is utilized in a system.
4. An optional instructional topic on ground-fault circuit interrupts may be presented in this unit if the instructor feels it is appropriate.

Supplemental Activities and Demonstrations:

1. Show students that our government does in fact look out for their safety and protection. Point out the function of the National Electrical Code and Underwriters' Laboratories. Demonstrate where the UL label can be located and why it is so vital in providing a margin of safety.
2. Obtain an older plug type Edison base fuse and show it to the class. Explain that this type of fuse is no longer allowed in home construction because it is considered to be tamperable. Extract from the class whether they think this fuse is too dangerous to be utilized in new homes and if they feel it is — specifically why?
3. Demonstrate the technique of checking for continuity of a fuse. Refer to the devices resistance as a means to evaluate its quality.

Instructional Module Contents:

1. Unit Outline (overhead)
2. Pre-Post Test (keyed)
3. Technical Glossary
4. Worksheet (vocabulary) - Know Your Definitions
5. Quest Activity
6. Informational Handout (Circuit Protection Devices)
7. Unit Module Answer Keys

XVIII. Circuit Protection Devices

A. Why Circuits and Equipment Require Protective Devices
   1. Runaway current

   2. Circuit failure

B. Types and Operation of Protective Devices
   1. Fuses

   2. Circuit breakers

C. Wiring Protective Devices Into an Electrical Circuit

D. Troubleshooting Circuits for Cause of Protective Device Failure

E. Maintenance Information for Fuses and Circuit Breakers

Test Number _____

LII-U18

UNIT EXAM

CIRCUIT PROTECTION DEVICES

IMPORTANT-
Indicate your responses on the answer sheet only. Fill in the box corresponding to the correct answer to each question - there is only one correct answer for each question.

1. A fuse or circuit breaker must be connected in series with the circuit it is protecting. (T-F)

2. When a fuse link melts, or "blows" the electrical result is an open circuit. (T-F)

3. Miniature cartridge fuses are often used in automotive and instrument circuits. (T-F)

4. An overload can be safely prevented by increasing the size of the fuse protecting the circuit. (T-F)

5. Circuit breakers are used mainly on instruments and appliances. (T-F)

6. A "short circuit" causes an extremely high current to flow through the circuit. (T-F)

7. Circuit protection devices are rated according to the maximum current or amperage which can flow through them. (T-F)

8. Circuit breakers require occasional maintenance which involves manually tripping the device on and off. (T-F)

9. Circuit breakers contain several replacement fuse links, that can be switched into position by moving a lever. (T-F)

10. A 15 ampere fuse would be correct for use in a home outlet or lighting circuit. (T-F)

11. If the correct size fuse in a circuit continually blows or burns out, it probably indicates that you purchased a bad box of fuses or that you need a larger value fuse. (T-F)

12. When the current flowing through a circuit breaker is below the devices rated value, the breaker will trip. (T-F)

13. A circuit overload can be caused by:
(A) using a fuse with a low amperage rating, (B) connecting too many loads into the circuit, (C) an accidental low resistance path, (D) either B or C.

14. A prolonged overload current:
(A) can be avoided by using a higher amperage rating, (B) will not affect the circuits operation, (C) may melt insulation and cause a short or fire, (D) usually will not trip a circuit breaker.

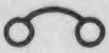
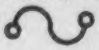
15. A short circuit:
(A) is an extremely low resistance path which causes higher than normal current flow, (B) cannot occur in a circuit protected by the proper size fuse or circuit breaker, (C) can occur only in an AC circuit, (D) seldom causes the fuse or circuit breaker to open.

Name: ____________________

Date: ____________________

TECHNICAL GLOSSARY

Period: ____________________

CIRCUIT BREAKER:	A circuit protection device which is basically a thermal or electromagnetic switch, designed to break the current flow through a circuit in case of an overload or short. Circuit breakers have an advantage over fuses in that they can be easily reset many times. Symbol:  Rated in amperes.
CIRCUIT PROTECTION DEVICE:	A device used to protect a circuit from the potentially destructive effects of excessive current. The most common circuit protection devices are fuses and circuit breakers.
FUSE:	A device used to protect a circuit against excessive current flow. Fuses contain a calibrated "fuse link" which burns or vaporizes when too much current begins to flow through it. Symbol:  Rated in amperes.
FUSE LINK:	The thin strip of fusible metal built into a fuse, that will melt when the current flow through it exceeds a preset value. The higher the blow-out current rating, the larger the physical size of the fuse link. These links can take the form of hair thin wire or fairly thick strips of metal, and can be calibrated to one hundredths of an amp. (1/100).
OVERLOAD:	An unsafe circuit condition which occurs when a circuit carries more current than it can safely handle. Overloads can cause excessive heat, fire, or an electrical explosion.
RUNAWAY CURRENT:	A circuit condition such as a short, which allows the current in a circuit to increase uncontrollably past the safe limits of the circuit.
SHORT CIRCUIT:	An accidental circuit condition which results in a low resistance path between two points of the circuit (power supply terminals, line, etc.). A shorted circuit causes excessively high current flow and possible circuit damage.
TROUBLESHOOTING:	The process of logically locating and correcting improper operating conditions within an electronic circuit or system.

WORD POWER!

SCORE:

GRADE:

Name: ____________

Date: ____________

Period: ____________

WORKSHEET

VOCABULARY - KNOW YOUR DEFINITIONS

Develop a short definition, using your own words, for the following terms.

1. FUSE:

2. OVERLOAD:

3. SHORT CIRCUIT:

4. TROUBLESHOOTING:

5. CIRCUIT BREAKER:

6. FUSE LINK:

SCORE:

GRADE:

Name: ________________

Date: ________________

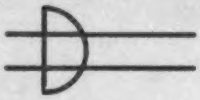
Period: ________________

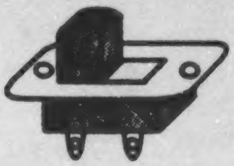
WORKSHEET

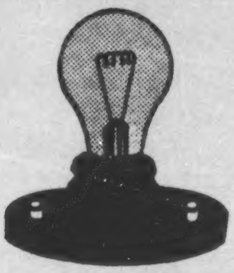
QUEST ACTIVITY

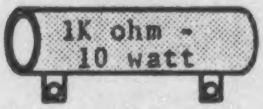
"UNIT 18"

1. Draw in the conductors and connect the circuit components below to form a series circuit. Add a fuse into the circuit so that it will act to protect the circuit against an overload or short.

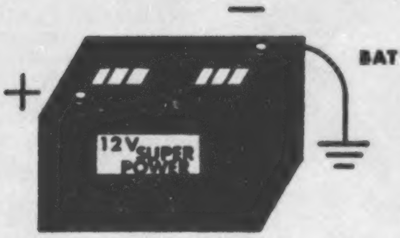




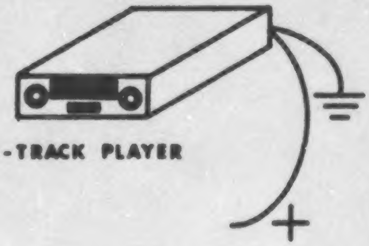




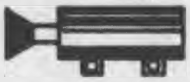
2. Connect the following automotive devices in parallel with the source, and in series with their controls. Add an in-line fuse to the tape deck branch, and a circuit breaker to the headlight branch.



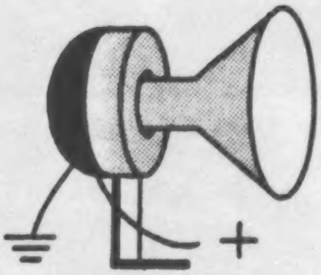
BATTERY



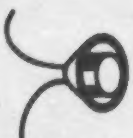
8-TRACK PLAYER



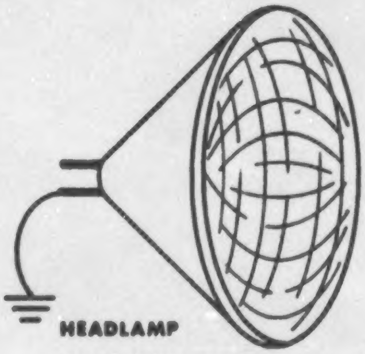
LIGHT SWITCH



HORN



PUSH BUTTON



HEADLAMP

Name: ____________________

Date: ____________________

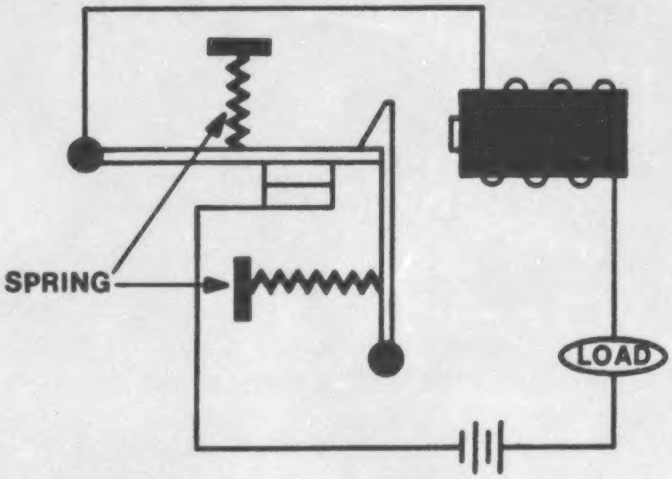
Period: ____________________

3. Draw a sketch of a fast acting (fast blow) and a slow acting (slow blow) fuse.

fast acting **slow acting**

4. Explain the purpose or need for a slow acting fuse.

5. Explain how the circuit breaker pictured below operates.



Name: ____________________

Date: ____________________

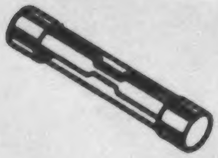
Period: ____________________

INFORMATIONAL HANDOUT

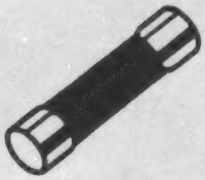
CIRCUIT PROTECTION DEVICES

Fuses or circuit breakers make up the major types of circuit protection devices in use today. These devices are used to protect against excessive current flow in a circuit and as such are rated in amperes. Fuses react to an abnormally high current by melting or vaporizing a special metal link which opens the circuit and halts the current flow. Circuit breakers contain either an electromagnet, or a bimetallic thermal strip, which opens a set of switch contacts when the breaker's rating is exceeded. Once the contacts open, the circuit current is stopped.

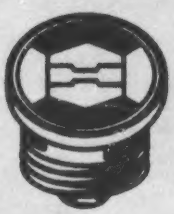
FUSE TYPES:



MINIATURE CARTRIDGE FUSE

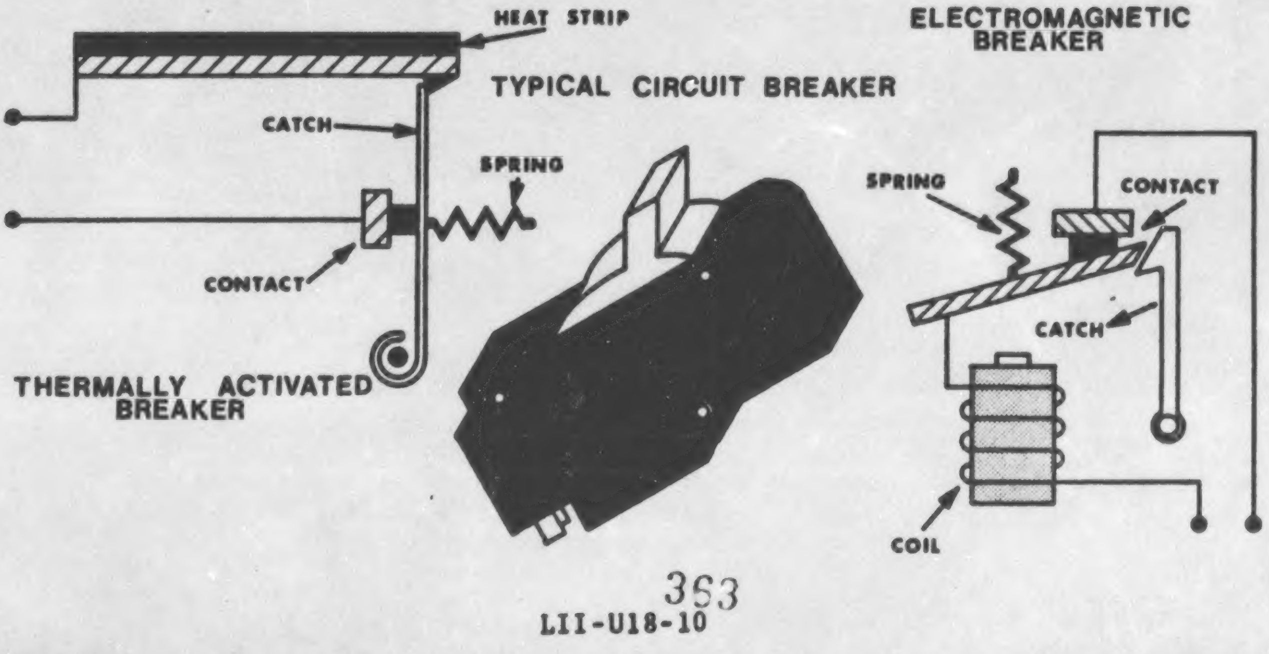


CARTRIDGE FUSE



PLUG FUSE

CIRCUIT BREAKER TYPES:


HEAT STRIP
TYPICAL CIRCUIT BREAKER
CATCH
SPRING
CONTACT
THERMALLY ACTIVATED BREAKER
ELECTROMAGNETIC BREAKER
SPRING
CONTACT
CATCH
COIL

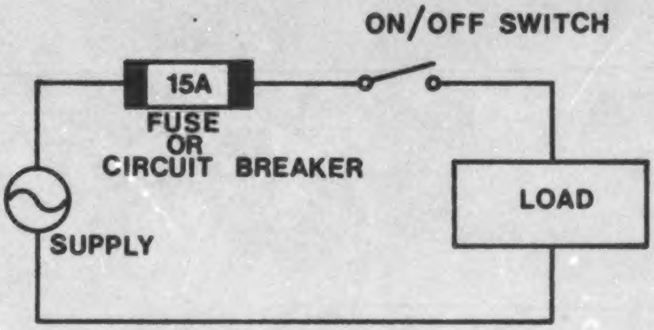
Name: ______________________

Date: ______________________

Period: ______________________

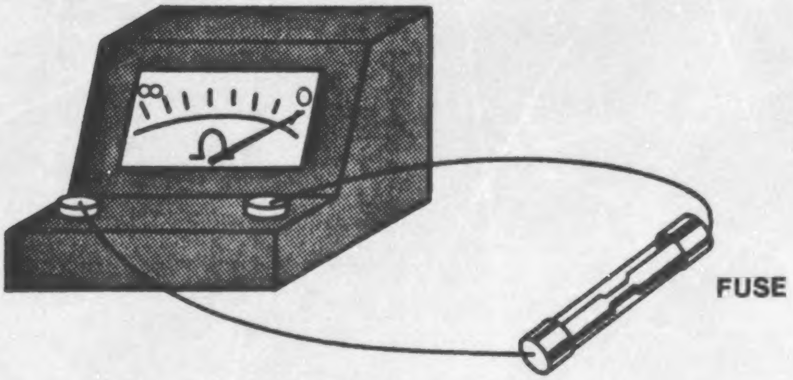
CIRCUIT CONNECTION:

To effectively protect a circuit from excessively high current flow, fuses and circuit breakers must be connected in series with the circuit they are protecting. A typical circuit application is shown below.


ON/OFF SWITCH
15A
FUSE
OR
CIRCUIT BREAKER
LOAD
SUPPLY

FUSE TESTING WITH AN OHMMETER:

Many times a quick visual inspection of a fuse's condition can be wrong. A fuse may look good when it is actually burnt out or defective. A sure fired way to check a fuse is to run a simple continuity test as illustrated below.



ANSWER KEY
UNIT 18

A. WORD SEARCH

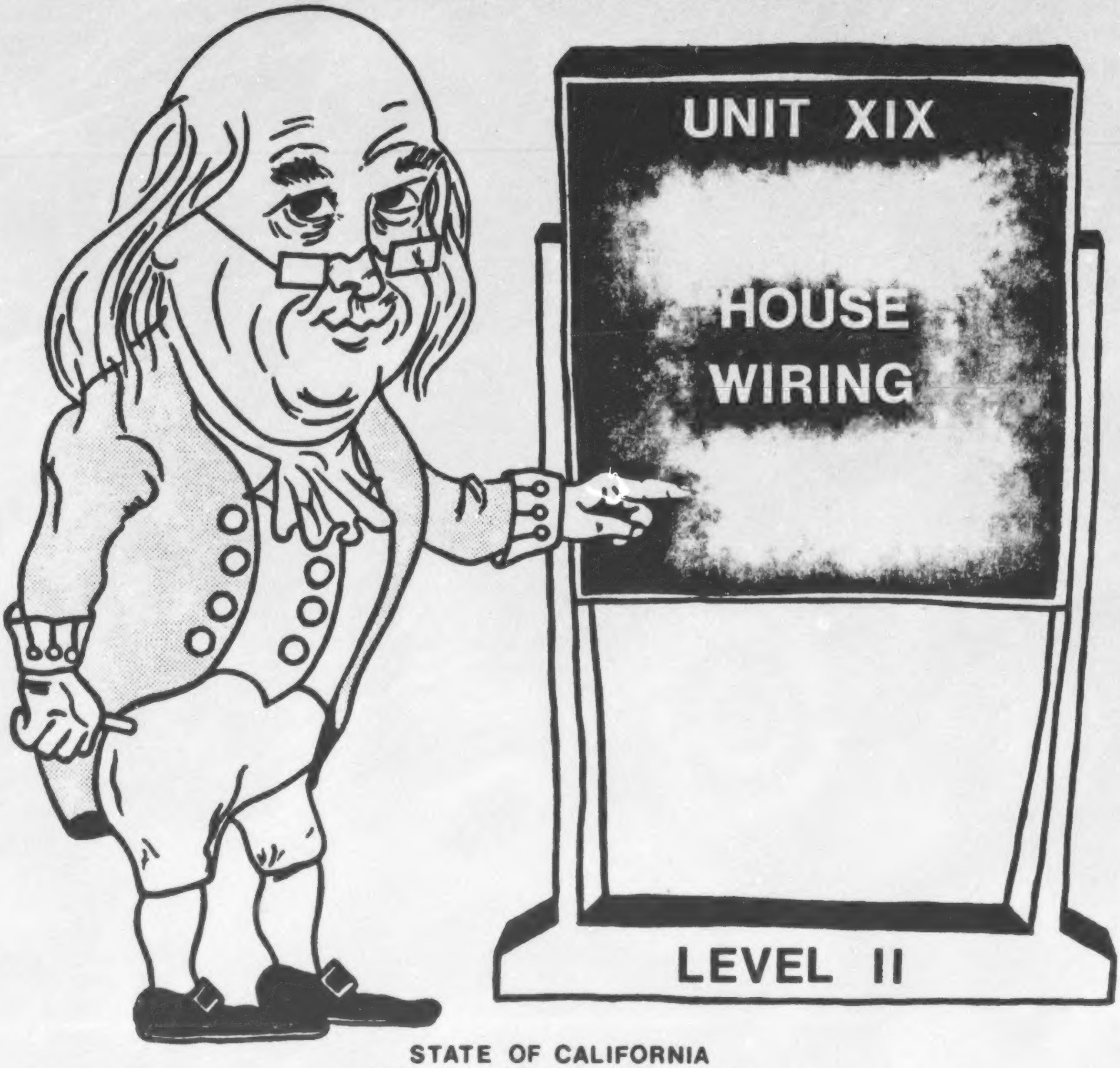
1. (subjective answer)
2. (subjective answer)
3. (subjective answer)
4. (subjective answer)
5. (subjective answer)
6. (subjective answer)

B. QUEST ACTIVITY

(subjective evaluation)

ELECTRICITY / ELECTRONICS

CURRICULUM GUIDE
INSTRUCTIONAL MODULE


UNIT XIX
HOUSE
WIRING
LEVEL II

STATE OF CALIFORNIA
DEPARTMENT OF EDUCATION

NAME______________________
DATE STARTED____________
DATE COMPLETED_________

BY
R. E. LILLO
N. S. SOFFIOTTO

STATE ELECTRICITY/ELECTRONICS CURRICULUM GUIDE
INSTRUCTOR'S GUIDE TO ACCOMPANY LEVEL II UNIT #19

Title of Unit: House Wiring

Time Allocation: 2 weeks

Unit Goal:

To achieve student competence in evaluating the common method in which power is delivered to the home, and to develop in students a technical familiarity with residential wiring materials and basic household circuitry.

Unit Objectives:

The student will be able to:

1. state the specific function of a service connection and describe in detail what is being measured by a kilowatt-hour meter.
2. identify and differentiate between a variety of basic electrical wiring components and materials including duplex receptacle, switch, conduit, sheathed cable, etc., which may be encountered when studying the composition of home electrical circuits.
3. demonstrate simple wiring skills and recite the technical procedures necessary to accomplish the replacement of a fuse, resetting of a circuit breaker, and/or the replacing of an electrical switch or outlet.

Evaluation:

The student will demonstrate his/her competence in terms of these measurable objectives based upon individual instructors acceptable performance criteria, which may utilize a combination of written, oral, and laboratory testing procedures.

Instructor References:

Electricity and Electronics Basic. William B. Steinberg and Walter B. Ford American Technical Society, 1974. Units: 18 and 19.

Housewiring. Floyd M. Mix, Goodheart-Willcox Co., 1973. Units: All.

Industrial Electricity. Rex Miller, Chas. A. Bennett Co., 1978. Chapters: 6 - 8.

Overview:

Unit 19 is presented as a functional outgrowth of Units 16 and 17, and this unit should begin with a light review of basic concepts previously presented in those units.

The central idea or theme is to inform the student about basic house wiring circuitry. However, it is not recommended that they should attempt to install wiring in a home, but it is conceivable that they may have acquired enough fundamental competencies to allow them to safely complete a replacement job on a switch or outlet.

At the unit outset concentrate on explaining the purpose of the service connection along with the related knowledge of reading a kilowatt-hour meter.

Next, describe typical electrical materials that are associated with electrical construction wiring. Also, emphasize various kinds of household circuits along with some simple repair installation procedures.

Suggested Presentation Hints/Methodology:

Follow the instructional unit module outline as a basic skeleton for curriculum presentation, however, note the following:

1. This unit is far more effective if the students have an opportunity to interact with the actual materials and wiring apparatus. If a commercially produced wiring demonstrator is not available it is fairly easy to create a usable instructional device to further facilitate this unit of instruction. Work with the wood and drafting instructors and design a portable wall demonstrator that can be rotated into the different labs as needed to illustrate various principles in house construction, architectural design, and/or residential wiring. The wall trainer should be able to accomodate several students on an individualized paired basis, and it should realistically simulate a wall and partial ceiling section. Additional electrical parts and materials such as; switches, lights, watt-hour meter, romex, signalling devices, fixtures, etc. may be mounted as desired to accomodate wiring experiments.
2. An interesting and economical instructional device which can enable students to easily comprehend electrical wiring techniques is simple to develop. Cut an assortment of 2' x 2' pieces of particle board, then cover each with "butcher" paper. Draw with a marker a pictorial diagram of a common residential wiring circuit. Have students mount appropriate parts right over the diagram and wire, Inspect, test, and grade their progress.

Supplemental Activities and Demonstrations:

1. Add a new dimension to a wiring wall trainer activity by having available in the shop 4 or 5 lab. coats of various sizes. A "logo" such as Joe's Electrical Repair or whatever else is desired can be affixed to the coat. If possible issue out standard electricians's type tool holders which can be strapped to their waist and filled with an assortment of tools and materials. This role playing atmosphere will generally stimulate students in a very positive manner as they progress in their activities.
2. Contact a local electrical company and ask if it would be possible to take slides of a crew working at a job site. Share these slides with the class and narrate the kinds of activities electrician's perform and the qualification and training which is typically required.

Instructional Module Contents:

1. Unit Outline (overhead)
2. Pre-Post Test (keyed)
3. Technical Glossary
4. Worksheet (vocabulary) - Word Search
5. Quest Activity
6. Informational Handout - (Electric Service Drop-Reading the Kilowatt-Hour Meter
7. Informational Handout - (Handy Hints About Basic Electrical Installation and Repair)
8. Unit Module Answer Keys

XIX. House Wiring

A. Service Connection

B. The Kilowatt-Hour Meter
    1. Electrical energy measurement

    2. Meter reading and energy cost

    3. Comparison of power used by different household appliances

    4. Method for conserving energy

    5. Relationship between human comfort and energy consumption

C. Wiring Materials

D. House Fixture Wiring
    1. Switching circuits

    2. Outlet circuits

E. Wiring Requirements for the Home

Test Number _____

LII-U19

UNIT EXAM

HOUSE WIRING

IMPORTANT-

Indicate your responses on the answer sheet only. Fill in the box corresponding to the correct answer to each question - there is only one correct answer for each question.

1. The amount of electrical energy consumed in your home is measured by a kilohour-watt meter. (T-F)

2. The individual dials of a kilowatt-hour meter all have the same kwh value. (T-F)

3. The basic energy unit upon which electric companies base their customers bills, is the watt-hour. (T-F)

4. The kilowatt-hour meter is connected between the entrance head and the distribution panel in such a way that all energy consumed can be accurately measured. (T-F)

5. A branch circuit and a series circuit are the same. (T-F)

6. The bare copper wire found in house wiring systems is always a "hot" wire. (T-F)

7. Normal home electric service is designed to supply both 120 volts and 240 volts. (T-F)

8. The advantage of a fuse, is that it can be easily reset by moving a switch lever. (T-F)

9. The standard color coding for the neutral wire used in house wiring, is white. (T-F)

10. When installing a duplex outlet, the brass attachment screw is connected to the "hot" or black wire. (T-F)

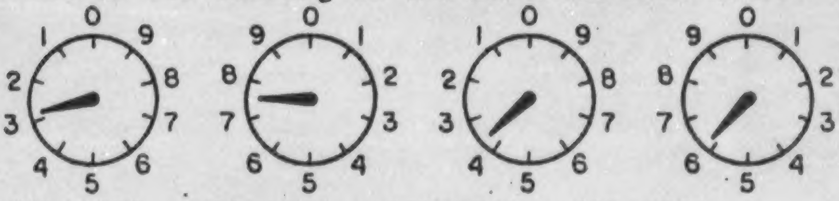
11. A circuit overload will generally not cause a circuit breaker to trip. (T-F)

12. It is perfectly safe to replace a wall switch or duplex outlet without turning off the main power, if you work carefully. (T-F)

13. Each branch circuit in the home should contain either a fuse or a circuit breaker to prevent short circuit conditions. (T-F)

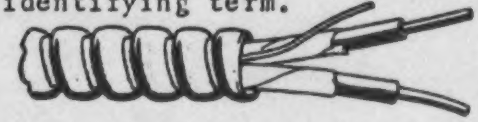
14. Overloaded glass cartridge fuses can be identified by an open or burned fuse link. (T-F)

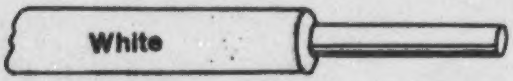
15. What is the reading on the kilowatt-hour meter?

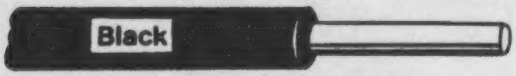


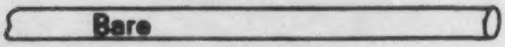
(A) 6372, (B) 2736, (C) 3746, (D) 2746.

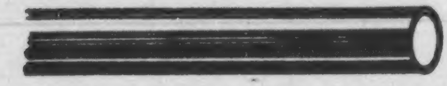
Identify the following residential wiring items by matching the sketch with the item description. On your answer sheet record only the letter of the identifying term.

16. 

17. 

18. 

19. 

20. 

E. Hot wire
F. Cover plate
G. Wall switch
H. Armored cable
I. Lamp socket
J. Crimp connector
K. Distribution panel
L. Conduit
M. Neutral wire
N. Twist Connector (wire nut)

O. AC plug

P. Receptacle (110V)

Q. Entrance head

R. Box

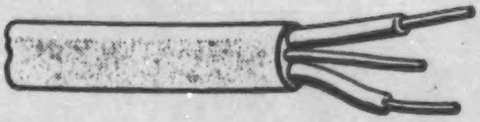
S. Nonmetallic sheathed cable

T. Ground wire

U. Kilowatt-hour meter

V. Fixture box

21.



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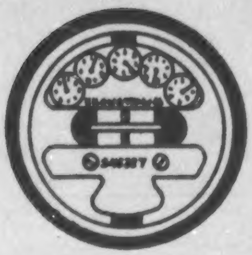

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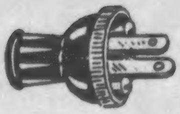

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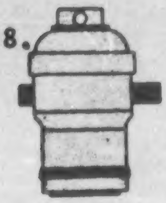

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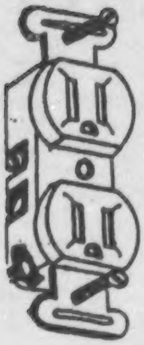

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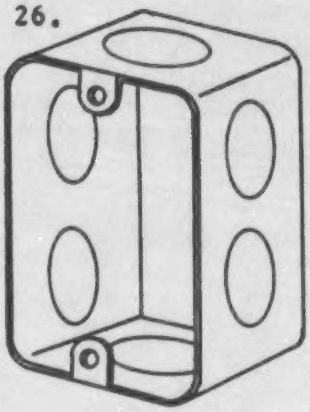

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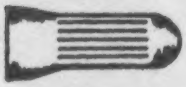

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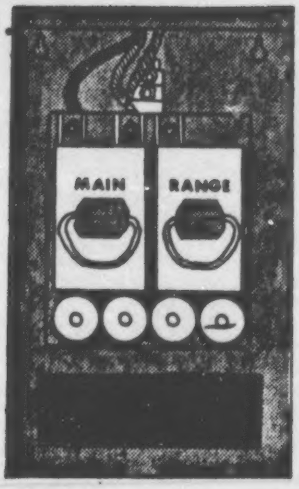

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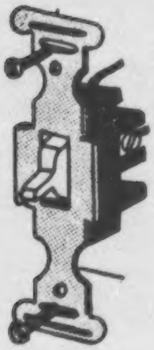
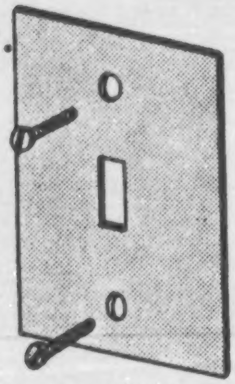


27.

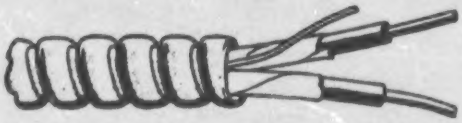


Name: ______________

Date: ______________

TECHNICAL GLOSSARY

Period: ______________

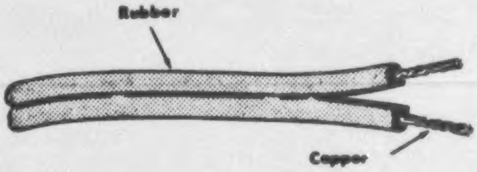
AC PLUG:	A two or three prong plug attached to one end of a line cord. The AC plug will mate with the wall outlet or recepticle to provide a contact with the 120V source.
APPLIANCE CIRCUIT:	A house wiring circuit, generally found in the kitchen and laundry areas, which is designed to supply the power required to operate large appliances such as a dish washer, refrigerator, microwave oven, washing machine, etc. The circuit is probably designed for a 20 ampere current flow, requiring at least 12 gauge wire.
ARMORED CABLE:	A semi-flexible, metallic sheathed cable used for interior wiring. Armored cable is generally used when wiring 220V circuits, such as electric ranges and clothes drier circuits. 
BOXES:	A steel or nonmetallic box attached to a stud or inner wall, and used to house switches, outlets, or lighting fixtures, and their connecting wires.
BRANCH CIRCUIT:	A parallel circuit, which supplies current to various load devices from a single voltage source. Outlet circuits are generally connected as branch circuits, each branch being protected by a fuse or circuit breaker.
COLOR CODING (WIRE):	A conductor identification system designed to code wire function by using various colors. Wires of different colors are not usually connected together. For residential application, white is used to indicate neutral, black denotes the hot wire, and green represents earth ground.
CONDUIT:	Thin walled metal tubing, usually 3/4 inch or 1 inch in diameter, used to house electrical conductors or wires.
CONSERVATION:	The process of saving or limiting the use of a resource, such as electrical energy.
DISTRIBUTION PANEL:	A panel or box, usually found directly below the kilowatt-hour meter, which contains the main switch used to turn off the electricity to the home, and the various fuses or circuit breakers used to protect the various house circuits. All wiring for each branch circuit begins at the distribution panel.
ELECTRIC SERVICE PANEL:	The main panel or cabinet through which electric power is brought into the home and distributed to the various branch circuits. The service panel generally contains the kilowatt-hour meter, the main power disconnect, and the circuit breakers or fuses for each branch circuit.

Name: ____________________

Date: ____________________

Period: ____________________

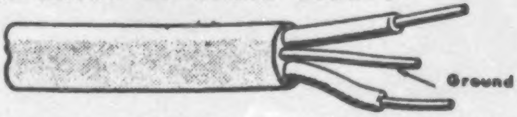
GENERAL PURPOSE CIRCUIT:	A house wiring circuit used for lighting fixtures and outlets in all rooms except the kitchen and laundry area. One general purpose branch is used per each 500 sq. feet of floor space and is generally protected by a 20 amp. 120V fuse.
GROUNDED:	Refers to a wire or conductor which is connected to the earth.
GROUNDING WIRE:	An additional wire used in an electric circuit as a safe guard against electrical shock. In house and appliance circuits, this wire is color coded green. During normal circuit operation, the grounding wire is not in use, but in an abnormal situation such as a live wire accidentally coming in contact with the frame, the grounding wire provides a safe path for electron flow.
HOT WIRE:	Any wire that carries electrical current. In the home these wires can be any color except white and green, but are usually black, blue or red in color.
INDIVIDUAL CIRCUIT:	A branch circuit in the home designed to serve individual pieces of electrical equipment such as ranges, water heaters, air conditioners, etc. Each individual circuit is protected by a fuse or circuit breaker.
KILOWATT-HOUR:	The electrical unit of measure for the amount of power/energy consumed in the home. Abbrev. KWH.
KILOWATT-HOUR METER:	A meter used to monitor and record the amount of electrical energy consumed in the home. The kilowatt-hour meter is connected in series with the service drop, and is read monthly by the electric utility company. These monthly readings form the basis for computing your electric bills.
LAMP SOCKET:	A screw type socket used to hold an electric light bulb. The socket provides an electrical contact for the contact points in the light bulb and may also contain an on-off switch.
LINE CORD:	A group of two or three stranded flexible conductors used to connect lamps and appliances to outlets. Line cords can be grouped into three basic types: lamp or fixture cords, appliance or heater cords, and service or power cords. The main differences between the types lies in the gauge of the stranded conductors and the kind of insulation used.



Name: ____________________

Date: ____________________

Period: ____________________

NATIONAL ELECTRICAL CODE:	A set of rules written by the National Fire Protection Association and the American National Standards Institute. The purpose of these rules is to safeguard persons, buildings, and contents, from hazards arising from the use of electricity. Following the standards set down by the National Electrical Code will result in buildings essentially free from hazard.
NEUTRAL WIRE:	The white colored wire or conductor used in house wiring is known as the neutral or ground return wire. This wire must be grounded at the main switch or fuse panel and run to each outlet without being broken or interrupted.
NONMETALLIC SHEATHED CABLE:	An assembly of two or more insulated wires with an outer sheath or covering of a moisture-resistant, nonmetallic material. Also known as romex cable. 
RECEPTICLE:	A contact device, sometimes referred to as a wall outlet or a duplex recepticle, which provides a point to plug in 120V devices such as lamps, toasters, etc. Outlets can be purchased with or without a grounding terminal. Although it is always desireable to use the grounding terminal when possible.
SERVICE DROP:	The conductors which extend from the street main lines or the pole transformer to the home. A typical house service consists of three wires, two 115V lines and one neutral wire.
SOLDERLESS CONNECTOR:	Also known as a wire nut or twist connector. These devices are used to connect two or more wires in a semi-permanent or permanent manner. Basically these devices are tapered, internally threaded plastic insulators which twist on to the bared ends of the conductors to hold them together firmly.
THREE-WAY SWITCH:	A type of wall switch which requires three connections rather than the normal two. A pair of three-way switches can be used to control a light from two different locations.
WALL SWITCH:	A tumbler switch. A device used to open and close the current path of a circuit. Wall switches are typically used in the home to turn lighting circuits on and off. Switches are used only on hot wires (black, blue, or red) and never on neutral or grounded wires.
WIRE GAUGE:	A numerical system for sizing wires commonly called AWG (American Wire Gauge) number. The larger the wire number, the smaller the diameter of the wire. Common AWG sizes for house wiring are 10, 12, or 14 gauge.

SCORE:

GRADE:

Name: ______________

Date: ______________

Period: ______________

WORKSHEET

VOCABULARY - WORD SEARCH

Locate the electrical terms in the matrix below, and record your findings in the spaces provided. The first letter of each term is given to you. Circle the terms on the matrix below. Words may be forward, backward, vertical, horizontal, or diagonal but must be in a straight line.

```
A G C Z F T I J J G L A M P S O C K E T S O P T F
H I O L M J D I S T R I B U T I O N D O U A A H U
S J N A K Q L I N E C O R D N O P C R R Q R O R N
X M D E R H U P D Q N E U P K M K C S U M R T E Y
R G U G U O Z A C P L U G N T M N N C O B V J E F
M O I N E T Z B E A A I Y I D R O S R H K L O W B
H E T L H W R E C E P T I C L E K E L T T I P A L
P E C V C I S A E T M N V T R S D R T T J O A Y H
B O X E S R A S L U L O L F N C T V K A X E N S I
L R M D B E U L K W Y C S O A L Y A G W W I E W L
N I S E G U A G E R I W O B N D E T P O Z I M I P
E L E C T R I C L B C R L U A N J I C L A B A T A
D I C B T U K Q E K J E E V E V O O H I M W L C E
H C T I W S L L A W Y R S Z P L J N X K E W S H D
T H M S E R V I C E D R O P Z A P E L Q R E W X E
```

1. C ______________
2. C ______________
3. G ______________
4. L ______________
5. L ______________
6. A ______________
7. A ______________
8. B ______________
9. K ______________
10. N ______________
11. R ______________
12. S ______________
13. T ______________
14. W ______________
15. W ______________
16. H ______________
17. D ______________
18. E ______________

SCORE:

GRADE:

Name: ____________________

Date: ____________________

Period: ____________________

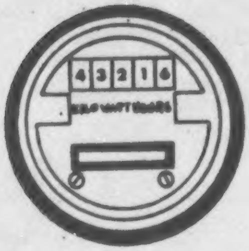
WORKSHEET

QUEST ACTIVITY

"UNIT 19"

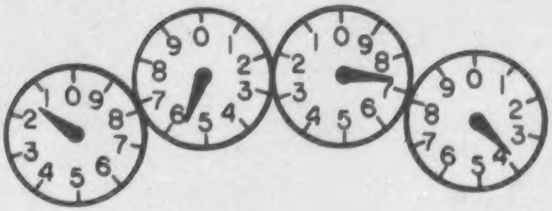
Read the values indicated on the kilowatt-hour meters pictured below:

1.



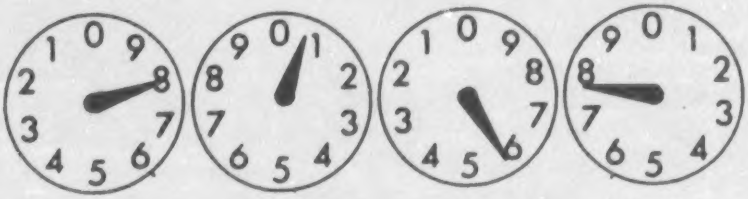
1. ☐

2.



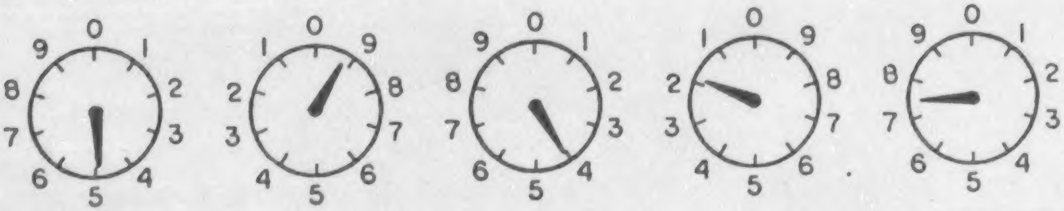
2. ☐

3.



3. ☐

4.



4. ☐

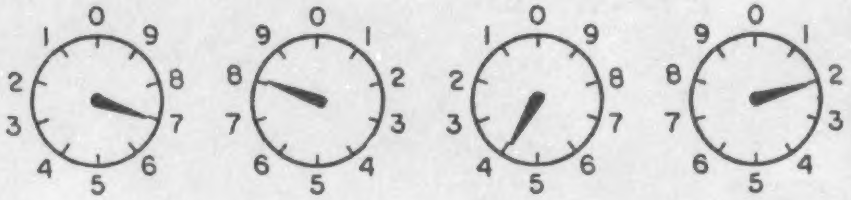
Name: ______________________

Date: ______________________

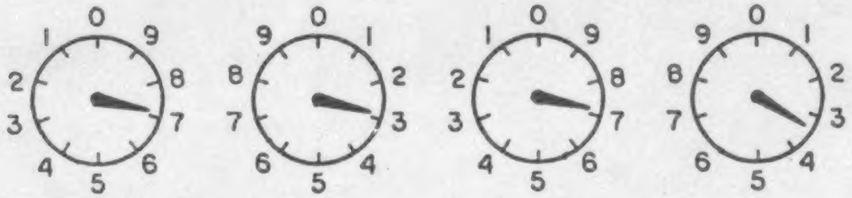
Period: ______________________

5A. Determine the number of kwh's of electricity consumed by this consumer by using the meter scales below.

5A.


1 0 9 2 8 3 7 4 5 6
9 0 1 8 2 7 3 6 5 4
1 0 9 2 8 3 7 4 5 6
9 0 1 8 2 7 3 6 5 4

Reading taken on Dec. 31


1 0 9 2 8 3 7 4 5 6
9 0 1 8 2 7 3 6 5 4
1 0 9 2 8 3 7 4 5 6
9 0 1 8 2 7 3 6 5 4

Reading taken on Jan. 31

Show work

5B. Compute the cost of this electrical energy if each kwh is billed at a rate of $.021 with an additional basic service charge of $1.60.

5B.

Show work

Name: ____________________

Date: ____________________

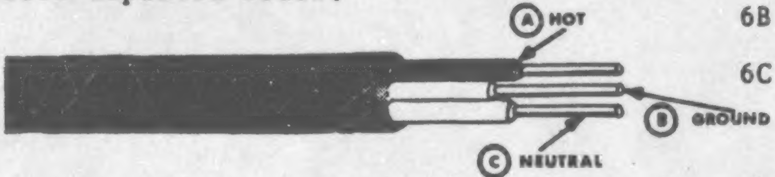
Period: ____________________

6. Indicate the N.E.C. standard color code for the house wires depicted below.

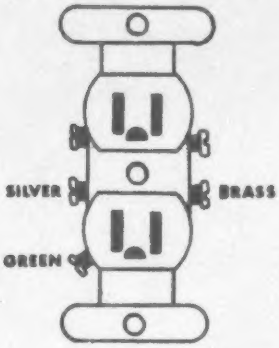
6A. ☐

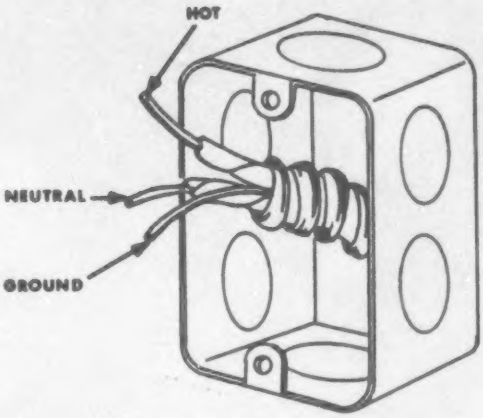
6B. ☐

6C. ☐

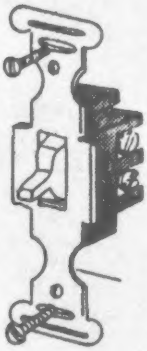

A HOT
B GROUND
C NEUTRAL

7. Route, and correctly connect the wires coming from the armored cable to the duplex outlet.


SILVER
BRASS
GREEN

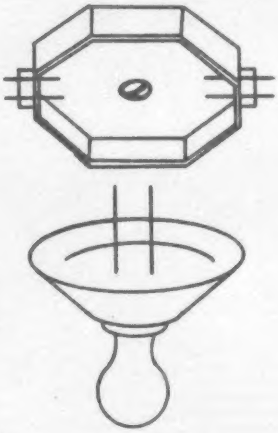

HOT
NEUTRAL
GROUND

8. Wire the wall switch circuit below in such a way that it will control the operation of the lamp.

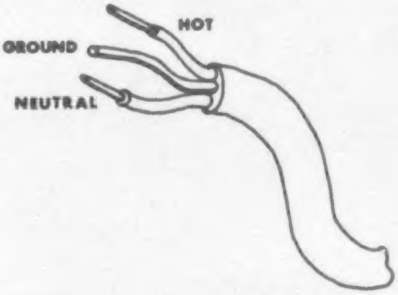


Switch

Ceiling Box



Socket


HOT
GROUND
NEUTRAL

Source

Name:

Date:

Period:

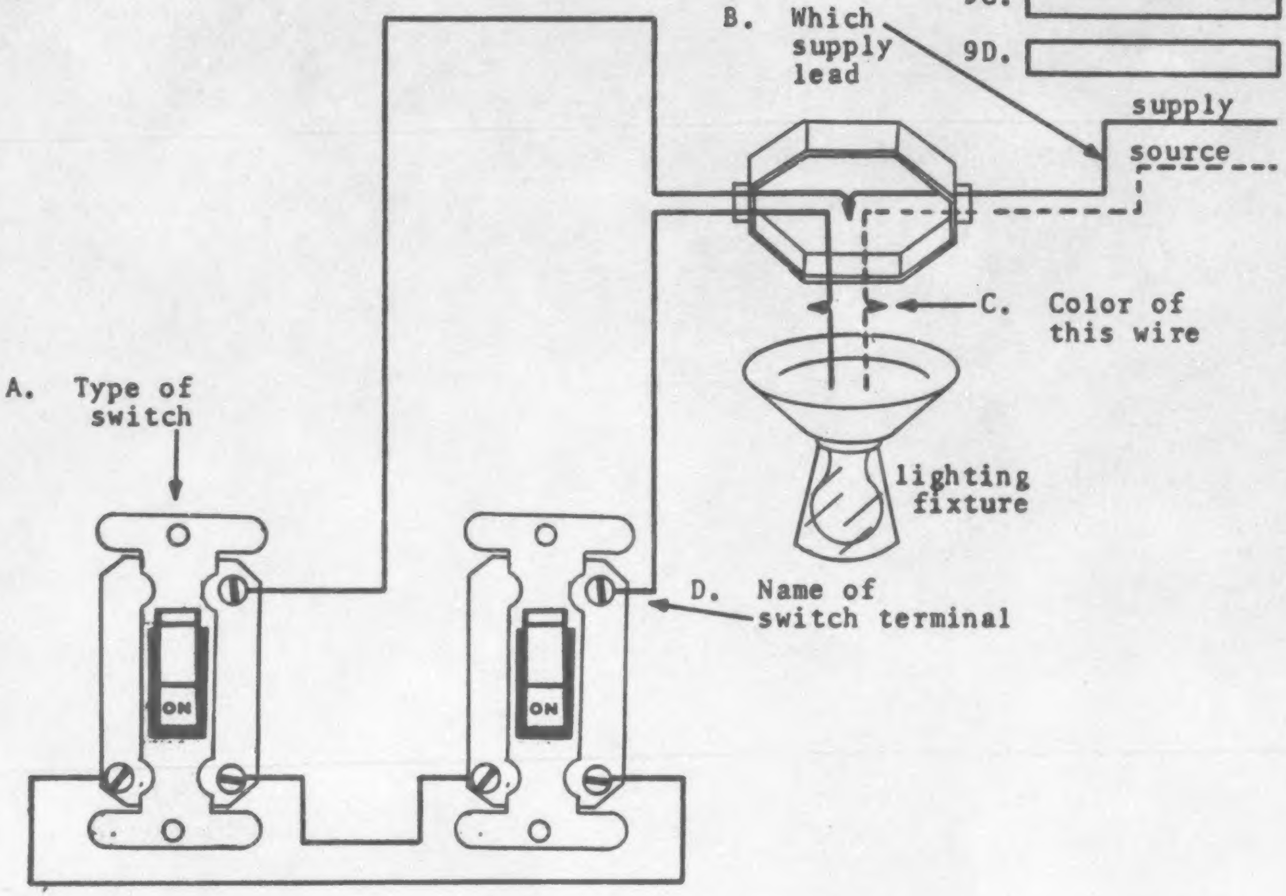
9. Identify the items asked for in the lighting circuit below.

9A.

9B.

9C.

9D.


B. Which supply lead
supply source
C. Color of this wire
lighting fixture
A. Type of switch
ON
ON
D. Name of switch terminal

10. Explain the purpose of a three-way switch circuit.

Name: ________________

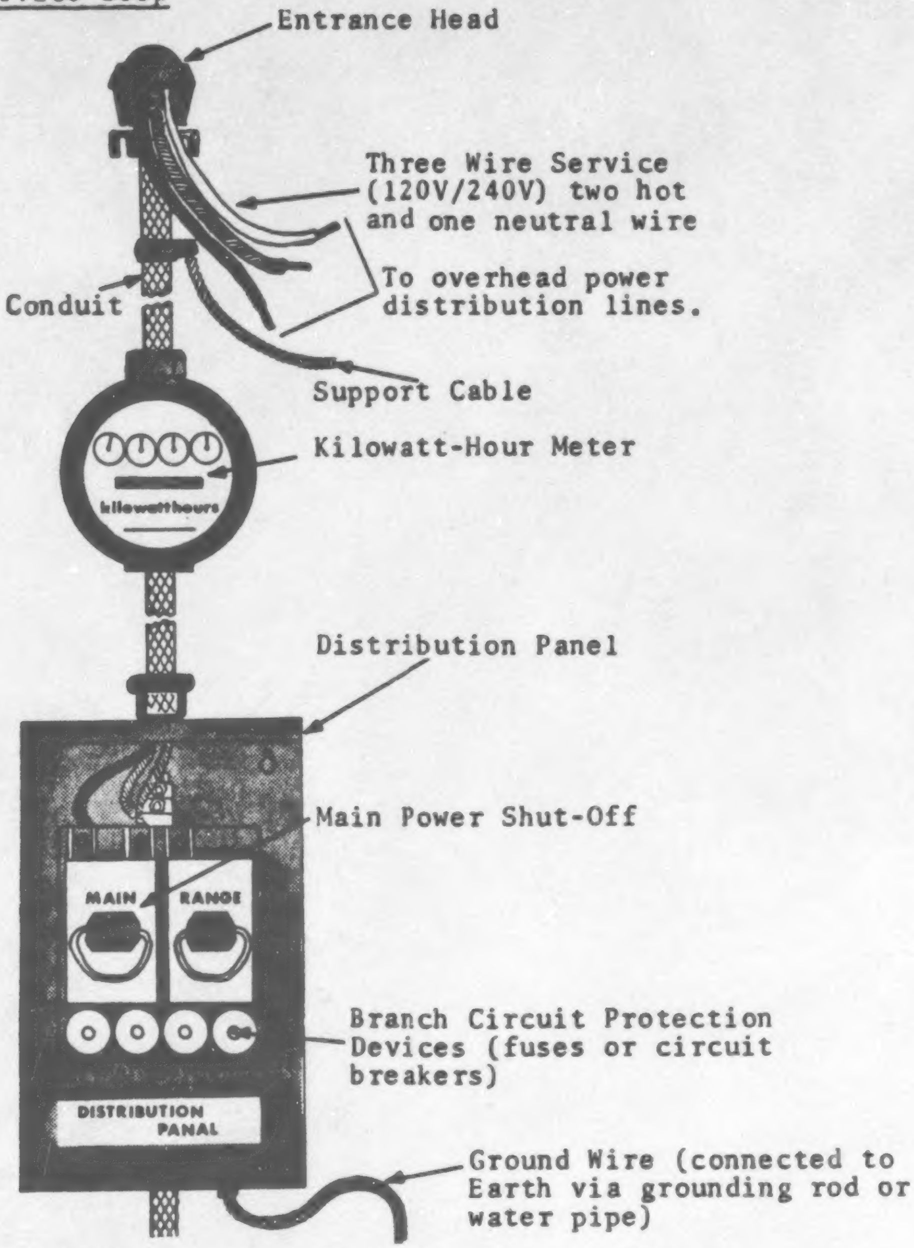
Date: ________________

Period: ________________

INFORMATIONAL HANDOUT

ELECTRIC SERVICE DROP - READING THE KILOWATT-HOUR METER

Electric Service Drop


Entrance Head
Three Wire Service (120V/240V) two hot and one neutral wire
To overhead power distribution lines.
Conduit
Support Cable
Kilowatt-Hour Meter
kilowatthours
Distribution Panel
Main Power Shut-Off
MAIN
RANGE
Branch Circuit Protection Devices (fuses or circuit breakers)
DISTRIBUTION PANAL
Ground Wire (connected to Earth via grounding rod or water pipe)

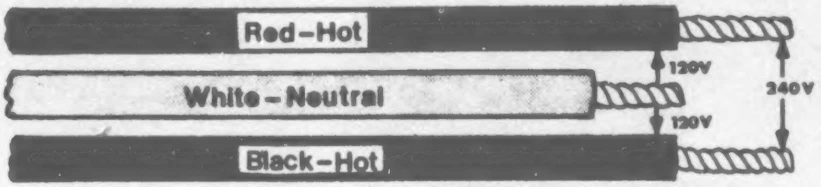
The electric service drop pictured above is typical of many power installations capable of supplying 120V/240V service to the home. Three wires, along with a support cable extend from the overhead distribution line to the entrance head on the house or building. Two of the wires

Name: ____________________

Date: ____________________

Period: ____________________

carry a 120V potential, and are referred to as the hot wires, while the third wire is a ground or neutral conductor. Voltages are developed across the conductors as shown below:



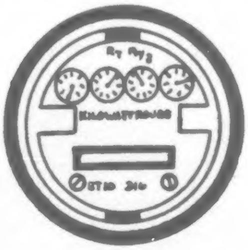
Along with the available voltages, a system must also be designed to handle a certain maximum current flow. Most single family homes are designed for either 100 or 150 ampere service.

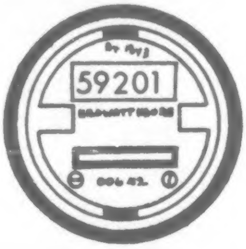
As electrical energy moves from the entrance head to the distribution panel, it flows through a kilowatt-hour meter. This meter is designed to measure the amount of electrical energy consumed in the home, and is monitored by the local power company. They in turn compute your monthly electric bill based upon the number of kilowatt-hours of energy used.

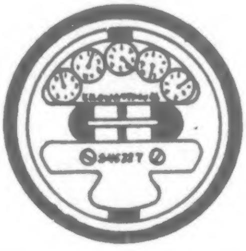
After flowing through the kilowatt-hour meter, the current is directed into the distribution panel. This panel contains the main power disconnect (a switch, fuse pack, or circuit breaker which can be used to turn off all power to the home) and the various protection devices (fuses or circuit breakers) used in each branch circuit. The wires then leave the circuit panel, and enter the house to form the various general purpose, appliance, and individual wiring circuits.

READING THE KILOWATT-HOUR METER

You may want to read your electric meter for several reasons; such as being able to compute your monthly electric bill, or to periodically check your consumption of electrical energy. Some meters have a numerical readout which is simple to read while other meters use a series of dials and pointers to indicate a measurement.







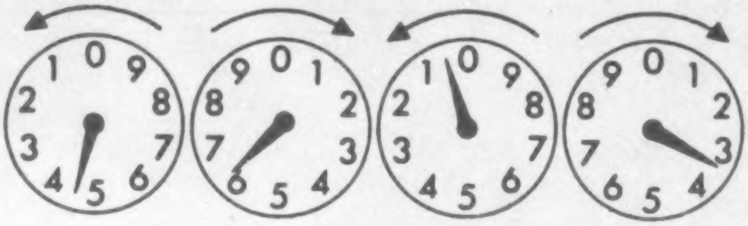
The drawing above shows several styles of kilowatt-hour meters. Locate your meter at home - it may be different from those pictured.

Name: ____________

Date: ____________

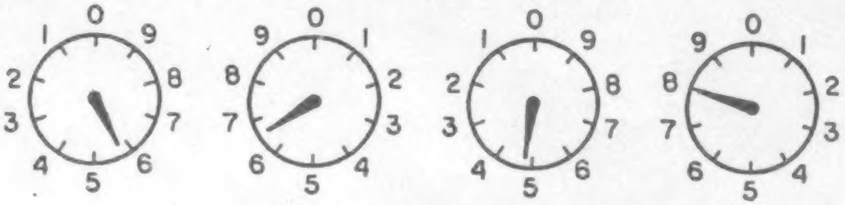
Period: ____________

The kilowatt-hour meter is basically a current sensitive motor, connected to a gear driven counter. On a dial type counter each adjacent pointer will rotate in the opposite direction as pictured below.



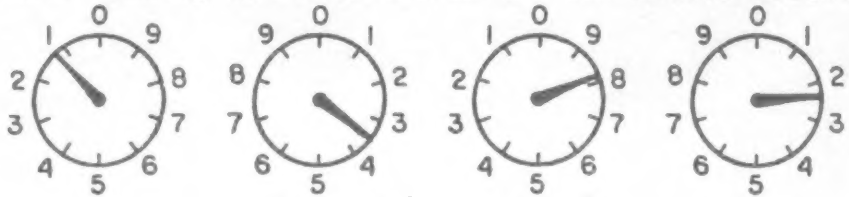
To read a meter similar to the one pictured above, start with the dial at the left, and write down the last number the pointer has passed on each dial. Thus the reading on the meter would be 4603 kilowatt-hours.

Let's try a few more sample readings.

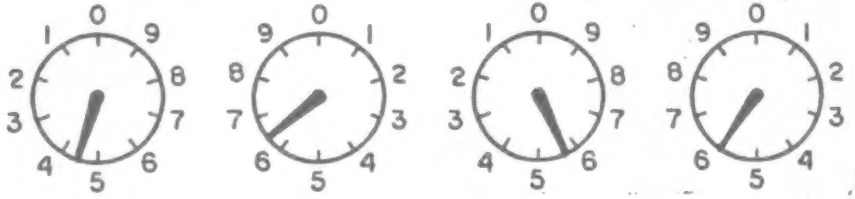


The meter pictured above is indicating a reading of 5648 kwh's. Notice; even though the pointer falls between two numbers, you always read to the lower value; also, each dial corresponds to a place value in our numbering system (ones, tens, hundreds, etc.).

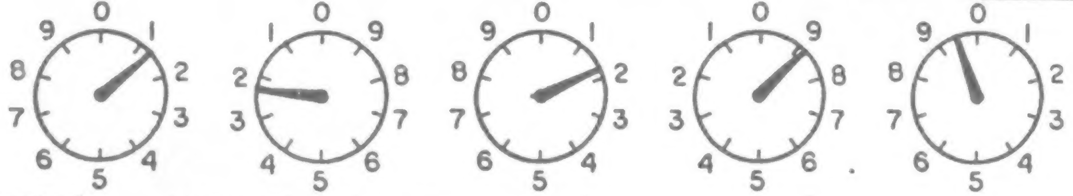
What reading is indicated on the kwh meters below?



Reading____________



Reading____________



ANSWERS: 1) 1382 2) 4656 3) 12189

Reading____________

Name: ______________

Date: ______________

Period: ______________

INFORMATIONAL HANDOUT

HANDY HINTS ABOUT BASIC ELECTRICAL INSTALLATION AND REPAIR

The sequency of tips that follow should only be utilized as a reference guide for minor electrical work.

Minor Work=

- Repair of blown fuses
- Resetting of circuit breakers
- Replacement of electrical switches and outlets
- Identification of an overloaded circuit

Major Work=

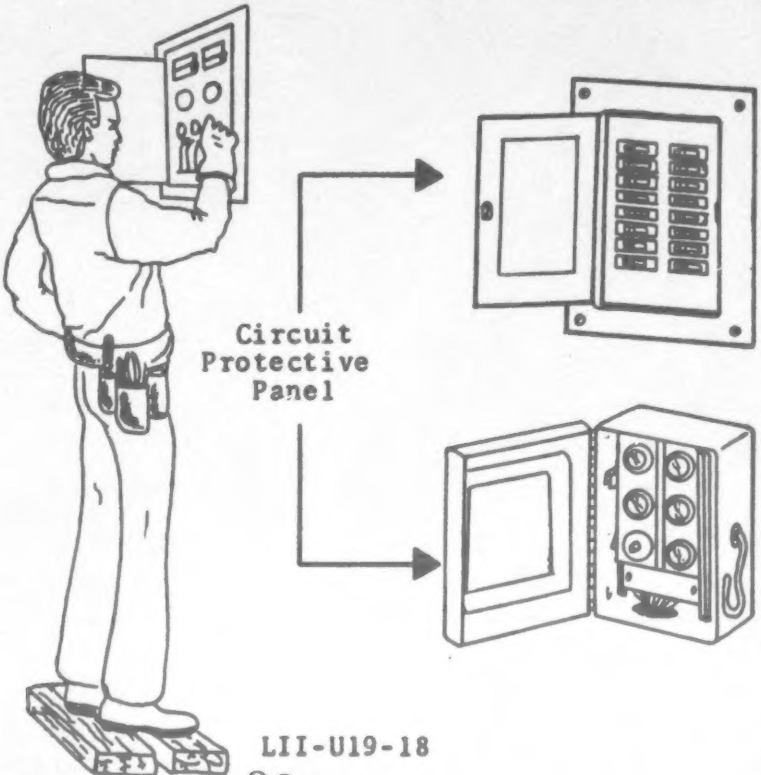
- Wiring which must conform to a standard or code, and generally requires a licensed electrician to complete.

SAFETY

Be safe-not sorry: Never work on a house circuit unless the main power or the power to the branch circuit is shut off!!! Double check.

Never touch a Circuit Protective Panel (fuse or circuit breaker box) unless you observe the following:

- Handle panels with one hand only!
- Wear insulating gloves
- Wear rubber soled shoes
- Stand on a board
- Know exactly what is proper to do for each situation



Name: ____________________

Date: ____________________

Period: ____________________

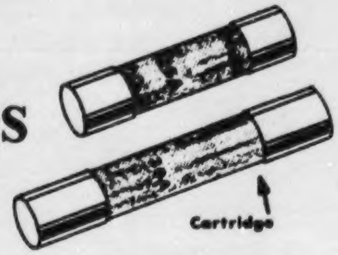
Fuses and Circuit Breakers

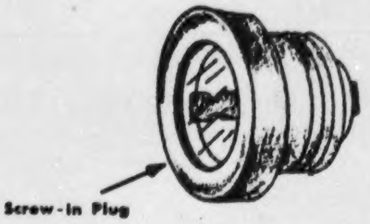
After the service connection, electrical power goes almost immediately to the Circuit Protective Panel where it is divided up into the appropriate branch circuits. The panel houses many circuit protective devices which will stop current flow when something is wrong!

< Shorted wires and circuits > —— **OR** —— < Overloads, appliance problems >

Fuses:

2 Basic Types





Many older homes use plug fuses and cartridge fuses and you should know how to replace them.

CARTRIDGE TYPE

*No visible indication when blown
*Installed in pull out drawers
*End cap on the meter side of the fuse is always hot
*Look at label on panel, find bad house circuit then replace that fuse - use wooden tool to remove old fuse
**Shut main power when replacing

Check this out!

PLUG TYPE

*Window discolored or metal strip broken when blown
*Only replace with proper size and type fuse
*Look at label on panel, find bad house circuit and locate bad fuse.
**Shut main power when replacing

Check these carefully!

FINAL CIRCUIT CHECKOUT

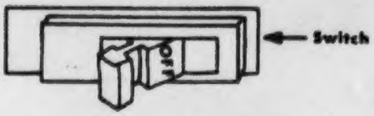
Before turning power back on remove all appliances from electrical circuit which was disabled. Turn the power on after fuse replacement and then plug each appliance in one at a time and observe the power. If the fuse blows again that last appliance must be repaired, and if all is "OK" the circuit was probably overloaded with too many items plugged in.

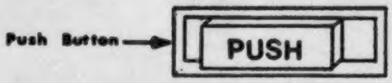
Name: ____________

Date: ____________

Period: ____________

Circuit Breakers:
2 Basic types





Many new homes in most areas use circuit breakers to protect wiring in the home.

SWITCH TYPE

*Located in panel enclosure
*Opens circuit automatically or manually
*When tripped switch will be labeled "OFF"
*Reset by switching to "ON" position

Review these!

PUSH BUTTON TYPE

*Located in panel enclosure
*Opens circuit automatically or manually
*When tripped button will "POP" out
*Reset by pushing it "IN"

Study this!

FINAL CIRCUIT CHECKOUT

Before resetting circuit breaker remove all appliances from electrical circuit which was disabled. Reset proper breaker then plug each appliance in one at a time and observe the panel and appliance. If the circuit breaker now trips, that particular appliance must be removed and repaired, and if all is "OK" the circuit was probably overloaded with too many items plugged in.

Replacing Wall Switches and Receptacles

Instructions in this section will describe a typical method for replacing a wall switch or outlet, but before we can start describing procedures make sure your familiar with these tools and color codes.

Common Tools To Use

- Screw driver
- Phillips screwdriver
- Long nose plier
- Knife

Electrical Wire Color Code	(Match-up)	Device Screw Color Code
Green	↔	Green
Red	↔	Brass
White	↔	Silver
Black	↔	Brass
Bare Wire	↔	Electrical Box (Ground)

Name: ____________________

Date: ____________________

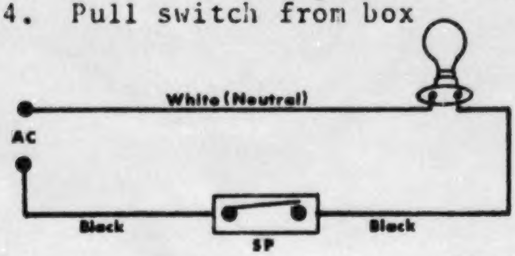
Period: ____________________

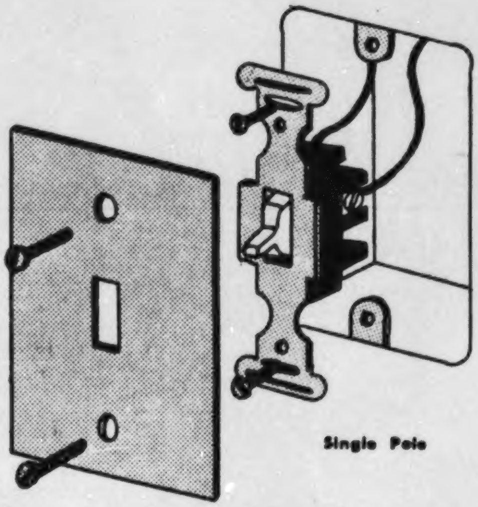
WALL SWITCH

Wall switches sometimes wear out, short out, or we are just tired of that type and want to replace it with a different kind of switch.

Here is how......

1. Shut power at panel
2. Remove cover plate
3. Remove mounting screws
4. Pull switch from box



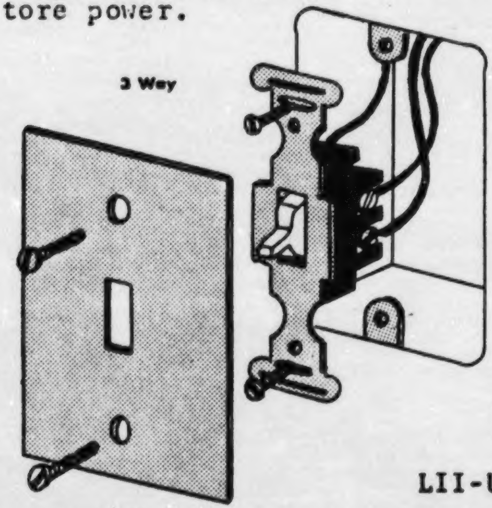


IF SWITCH IS......

"SINGLE POLE"
2 terminal screws

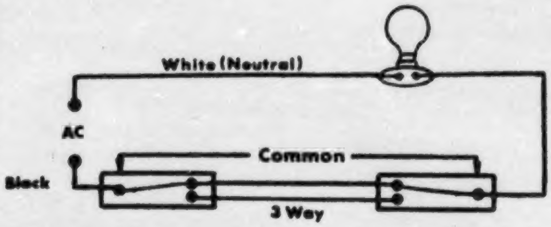
(Green wire not included in description)

5. Remove the two wires from the old switch.
6. Attach the two wires you just removed to the two terminals on the new switch (either order is ok).
7. Tighten the terminal screws.
8. Remount the switch in the box and replace cover plate.
9. Restore power.



"3-WAY SWITCH"
3 terminal screws

5. Identify the terminal on the old switch that is marked common or is of a different color from the remaining two terminals. (All switches do not look alike).
6. Remove the wire from that common terminal and attach it to the common terminal on the new switch.
7. Now remove the remaining two wires from the old switch and attach them to the remaining two terminals on the new switch (either order is ok).
8. Remount the switch in the switch box and replace the cover plate.
9. Restore power.



Name: ____________________

Date: ____________________

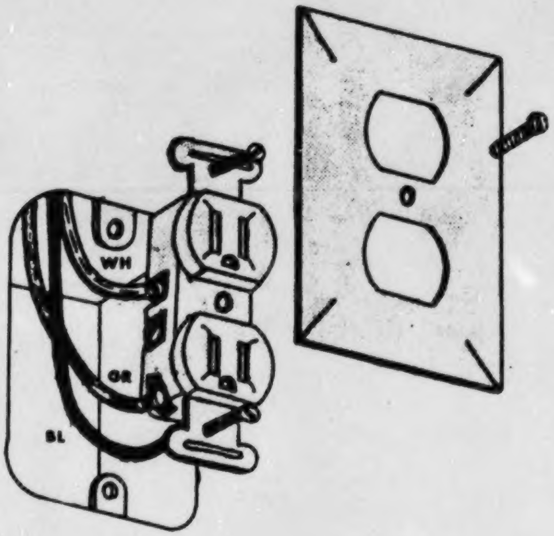
WALL RECEPTACLES - (Convenience outlets)

Period: ____________________

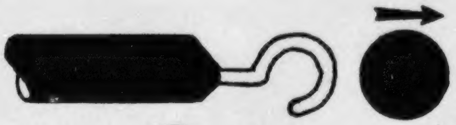
Receptacles or outlets sometimes wear out, short out, or we are just tired of that style and want to replace it with a different kind of receptacle.

Here is how......

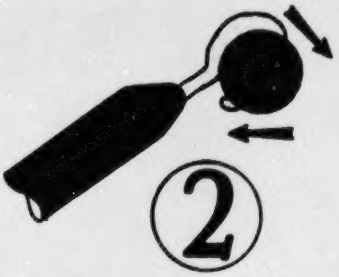
1. Shut power at panel.
2. Remove cover plate.
3. Remove mounting screws.
4. Pull outlet from box.
5. Loosen terminal screws and remove wires (or wire nuts).
6. Exchange outlets.
7. Install wires on proper screws while observing color code (black wire to brass screw, white wire to silver screw, and green wire to green screw).
8. Check that you have not connected a black wire to a white wire.
9. Mount outlet in box and replace cover plate.
10. Restore power.



Make sure wires are always carefully attached to the terminals of electrical devices. Place the bare loop around the screw so that it will be tightened by the clockwise motion when the screw is driven.



①



②

Remember, switches are installed properly only when they make or break the "hot" wire (black). The neutral wire (white) must never be interrupted by a switch.

Unlike switches wire coloring is always critical in electrical receptables, so never connect wires of a different color to each other or to the same terminal.

SCORE:

GRADE:

Name:

Date:

Period:

ANSWER SHEET

EXAM LII-U19

	T	F				T	F				T	F				T	F		
	A	B	C	D		A	B	C	D		A	B	C	D		A	B	C	D
1.		■			26.	R				51.					76.				
2.		■			27.	F				52.					77.				
3.		■			28.	I				53.					78.				
4.	■				29.	N				54.					79.				
5.		■			30.	K				55.					80.				
6.		■			31.					56.					81.				
7.	■				32.					57.					82.				
8.		■			33.					58.					83.				
9.	■				34.					59.					84.				
10.	■				35.					60.					85.				
11.		■			36.					61.					86.				
12.		■			37.					62.					87.				
13.		■			38.					63.					88.				
14.	■				39.					64.					89.				
15.		■			40.					65.					90.				
16.	H				41.					66.					91.				
17.	M				42.					67.					92.				
18.	E				43.					68.					93.				
19.	T				44.					69.					94.				
20.	L				45.					70.					95.				
21.	S				46.					71.					96.				
22.	U				47.					72.					97.				
23.	P				48.					73.					98.				
24.	G				49.					74.					99.				
25.	O				50.					75.					100.				

*Show work for problems on back of answer sheet.

ANSWER KEY
UNIT 19

A. WORD SEARCH

1. Conservation
2. Conduit
3. Grounded
4. Lamp socket
5. Line cord
6. AC plug
7. Armored cable
8. Boxes
9. Kilowatt hour
10. Neutral wire
11. Recepticle
12. Service drop
13. Three-way switch
14. Wire gauge
15. Wall switch
16. Hot wire
17. Distribution
18. Electric

B. QUEST ACTIVITY

1. 43216 KWH
2. 1573 KWH
3. 8057 KWH
4. 49417 KWH

5A. Jan. 31 7273
Dec. 31 6842
431 KWH

5B. 431 KWH
$.021 per KWH
431
862
9051
1.60 service charge
$10.65 Total cost

6A. black/Red
6B. green
6C. white

7. Hot lead to the right side brass terminal. Neutral lead to the left side silver terminal ground bare lead to green grounding terminal.

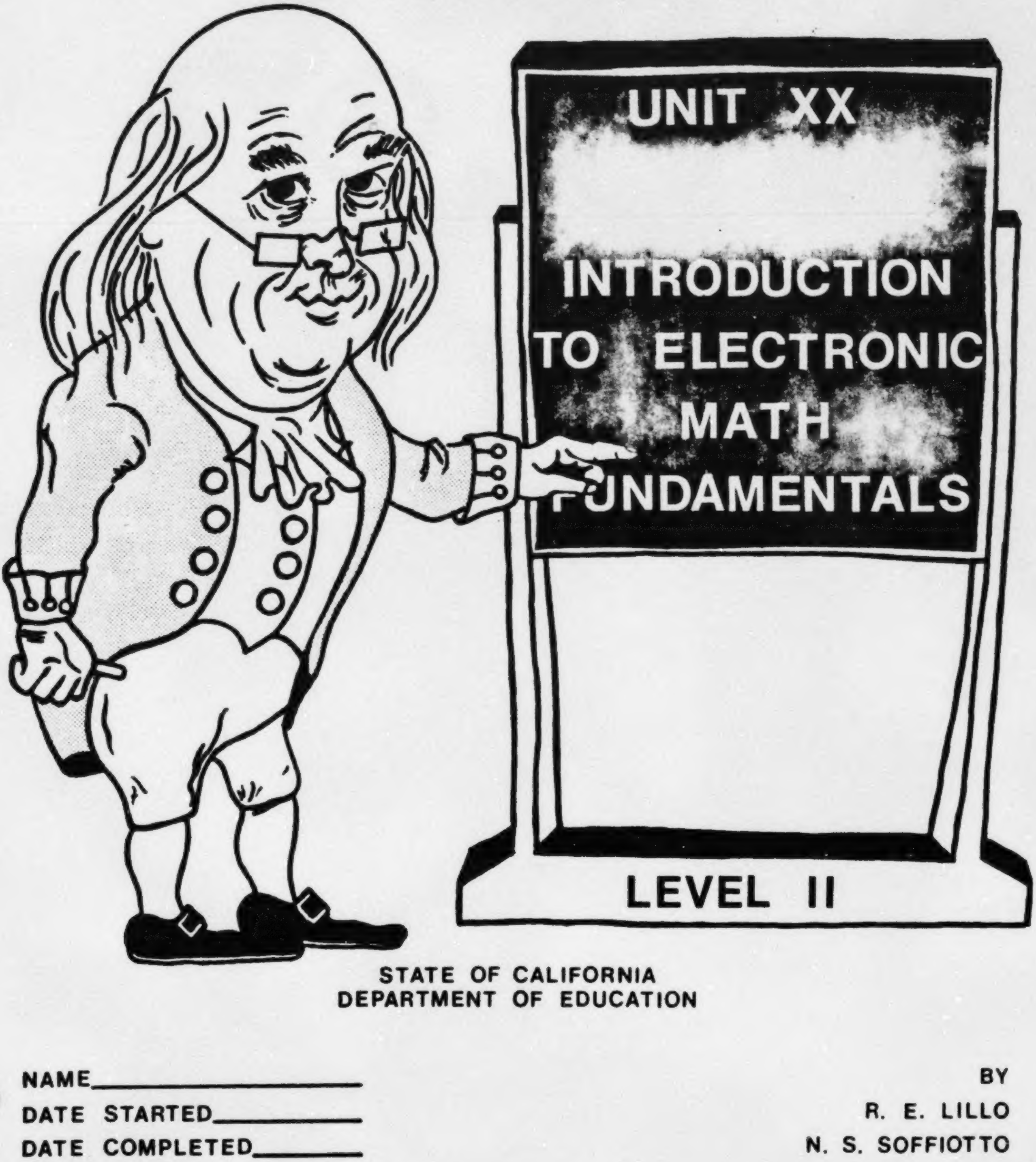
8. Route the hot lead from the source into the outlet box and wire nut to the black lead of a second two wire cable running to the switch. Route the white lead from the source into the outlet box and wire nut to the white lead of the light socket. Wire nut the remaining wire in the 2 wire cable in the outlet box to the black lead of the socket. The 2 wire cable is routed into the switch box and one wire is connected to either switch terminal the reamaining wire to the other terminal. The ground lead from the source is connected to a screw in the outlet box.

9A. 3 way switch
9B. hot
9C. white
9D. common connection

10. A three way switch circuit makes it possible to turn a light on or off from two different locations.

ELECTRICITY / ELECTRONICS

CURRICULUM GUIDE
INSTRUCTIONAL MODULE



UNIT XX

INTRODUCTION TO ELECTRONIC MATH FUNDAMENTALS

LEVEL II

STATE OF CALIFORNIA
DEPARTMENT OF EDUCATION

NAME________________

DATE STARTED__________

DATE COMPLETED________

BY
R. E. LILLO
N. S. SOFFIOTTO

Title of Unit: Introduction to Electronic Math Fundamentals

Time Allocation: 2 weeks

Unit Goal:

To investigate and reappraise a variety of mathematical competencies acquired in previous courses, and to utilize those fundamental skills as a foundation for introducing the **principles of technical math.**

Unit Objectives:

The student will be able to:

1. demonstrate through problem solving the proper procedures to follow when completing an addition, subtraction, multiplication and/or division problem.
2. apply the theory of scientific notation or "powers of 10" and successfully work a variety of problems as provided by the instructor.
3. manipulate the decimal point correctly when converting common subunits (decimal multipliers) to other units as directed.

Evaluation:

The student will demonstrate his/her competence in terms of these measurable objectives based upon individual instructors acceptable performance criteria, which may utilize a combination of oral or written testing procedures.

Instructor References:

Basic Mathematics for Electricity and Electronics. Bertrand B. Singer, McGraw-Hill Book Co., 1978. Chapters: 1-3.

Basic Mathematics for Electronics. Nelson M. Cooke and Herbert F. R. Adams McGraw-Hill Book Co., 1976. Chapters: 1-6, 7, and 20.

Vocational and Technical Mathematics in Action. Samuel Levine, Hayden Book Co., 1970. Chapters: 1-5, and 10.

Overview:

It was presupposed that basic mathematical skills have been presented to the student prior to this course. This unit was designed to review those competencies and to inform students in terms of related mathematical skills that can greatly support further technical achievement.

The beginning thrust of this unit then is obvious and important, to omit such a review would be a serious mistake. For many students a short, informative review will quickly re-establish their mathematical skills.

The topic of scientific notation may take a substantial amount of class time during instruction, however, the skill gained in handling numbers will be a valuable asset for the student.

Next, conversion of units should be presented. The importance of this topic cannot be overstated. Utilize many practice sessions and remember "repetition is the mother of learning."

Suggested Presentation Hints/Methodology:

Follow the instructional unit module outline as a basic skeleton for curriculum presentation, however, note the following:

1. Use a pre-test (Quest activity) designed just to review the following math skills: addition, subtraction, multiplication, division, fractions, decimals, powers, and square root. Analyze the results to determine what areas need to be reviewed in more depth. Without this kind of assistance the student will encounter tremendous difficulty. With the educational movement directed towards a philosophy of back to basics it is wise to continue to promote this kind of fundamental activity.
2. Calculators are a fantastic addition to the world of problem solving. Many students however, will disregard processes that must be performed to derive an answer because they will rely on the genius of the electronic calculator instead. The process must be stressed and the mathematical skill attained, then for rote problem solving the wizardry of the calculator may be employed.
3. The final topic in this unit refers to the techniques in applying a formula. For some students this is their first exposure to the process of solving for an unknown quantity. The instructor can really assist the student by examining the purpose of a formula, then drawing the analogy that a formula is like a cooking recipe which enables one to obtain desired results by adding together the correct ingredients.

Supplemental Activities and Demonstrations:

1. If a classroom computer like a TRS-80 or PET is available, do not hesitate to incorporate it as a means to reinforce the learning of basic mathematical skills. Program some simple skill exercises that will increase the proficiency of the user.
2. A fun type activity which demonstrates the usefulness of "scientific notation", and can be adapted into a game situation, is described as follows. Divide the chalkboard into two parts and ask a student to stand on one side, then write several large numbers to be multiplied as quickly as possible. In the meantime move to the unused section of the chalkboard and utilizing scientific notation complete the same problem. You should be finished about 2 days before the students. This will impress them with the quickness of this technique.

Instructional Module Contents:

1. Unit Outline (overhead)
2. Pre-Post Test (keyed)
3. Technical Glossary
4. Worksheet (vocabulary) - Scrambled Word Puzzle
5. Worksheet - Scientific Notation
6. Worksheet - Multiplication and Division Using Scientific Notation
7. Worksheet - Electrical Units and Conversion
8. Quest Activity
9. Informational Handout (Scientific Notation)
10. Informational Handout (Conversion of Electrical Units)
11. Informational Handout (Introduction to Mathematical Formulas)
12. Unit Module Answer Keys

XX. Introduction to Electronic Math Fundamentals

A. Review of Basic Mathematic Skills

B. Scientific Notation

C. Conversion of Electrical Units
   1. Common subunits: kilo, mega, milli, etc.

   2. Conversion method

D. Techniques in Applying a Formula

Test Number ____

LII-U20

UNIT EXAM

INTRODUCTION TO ELECTRONIC MATH FUNDAMENTALS

IMPORTANT-

Indicate your responses in the answer box only. Fill in the box corresponding to the correct answer to each question. There is only one correct answer for each question.

1. The abbreviation for milli is m. (T-F)

2. 100 **kilovolt** is greater than 1 megavolt. (T-F)

3. 1.5 x 5^{10} is a scientific notation expression. (T-F)

4. The electrical units volts, amperes, or ohms, are considered basic or base units. (T-F)

5. One microvolt is equivalent to .000001 volts. (T-F)

6. The expression $X = 10 + y^2$ is a mathematical formula. (T-F)

7. When converting from kilo to base, you should move the decimal point 3 places to the left. (T-F)

8. When multiplying numbers written in scientific notation, you should add the exponents together. (T-F)

9. The electrical units milli, micro, mega, and pico represent numbers less than zero. (T-F)

10. Pico has a power of ten equivalent of 10^{-9}. (T-F)

Convert the following scientific notation expressions to "regular" numbers.

11. 4.57×10^2 = ____________

12. 7.3×10^{-3} = ____________

13. 2.5×10^0 = ____________

Convert the following "regular" numbers into scientific notation. (Use proper form).

14. 560000 = ____________

15. .0089 = ____________

16. 555 = ____________

Solve the following problems:

17. $$\begin{array}{r} 1.4 \times 10^{6} \\ \times\ \ 8.9 \times 10^{-3} \\ \hline \end{array}$$

18. $$\frac{6.5 \times 10^{7}}{5 \times 10^{-3}}$$

Perform the following conversions.

19. Convert 2500 ohms to kilohms. ____________

20. Convert .005 amps to milliamps. ____________

21. Convert 450 microvolts to volts. ____________

22. Convert 8900 picoamps to microamps. ____________

23. Convert .6 megaohms to ohms. ____________

24. Convert 20 millivolts to volts. ____________

25. Given the formula: $\longrightarrow y = \frac{A \times B}{5}$

Solve for y if A = 5 and B = 15.

y = ____________

Name: ______________

Date: ______________

Period: ______________

TECHNICAL GLOSSARY

BASIC UNIT:	The fundamental or total value of a number or electrical measurement, written without abbreviations or prefixes. For example; volts, ohms and amperes are basic units, while millivolts, microamps, or kilohms are not basic units. 3k ohms can be expressed as the number 3000 ohms which is a basic value.
CONVERSION:	The process of changing a number or expression from one form into another equivalent form. Example: convert the number 5000 into scientific notation: 5×10^3.
DECIMAL POINT:	A dot or point which separates the whole number from the decimal fraction. The location of the decimal point establishes the value of the number. 57.25 decimal point 437.5 does not equal 43.75.
EXPONENT:	A number placed to the right and slightly above another number. The exponent is often called the "power," and indicates how many times a number is to be multiplied by itself. Example: 6^4 exponent means $6 \times 6 \times 6 \times 6 = 1296$
FORMULA:	A mathematical rule or procedure written in the form of an equation or mathematical sentence which contains an equals (=) sign between the known and unknown values. Example: $E = I \times R$ this formula explains how to find the value of "E" by multiplying the value of "I" times the value of "R".
KILO:	A prefix meaning 1000 (thousand). Abbreviated k. Example: 15k means 15000.
MEGA:	The prefix meaning 1,000,000 (million). Abbreviated M. Example: 5M means 5,000,000.
MICRO:	A prefix meaning .000001 (millionths). Abbreviated μ. Example: 6μ means .000006.
MILLI:	The prefix meaning .001 (thousandths). Abbreviated m. Example: 3m means .003.
NANO:	A prefix meaning .000000001 (billionths). Abbreviated n. Example: 8n means .000000008.
PICO:	The prefix meaning .000000000001 (millionths of a millionth). Abbreviated p. Example: 4p means .000000000004.
POWER OF TEN:	An exponent or power of the number 10 which can be used to abbreviate numbers such as 1,000,000 (10^6) or .000001 (10^{-6}). power of ten expression

Name: ____________________

Date: ____________________

Period: ____________________

PREFIX:	A metric term or letter abbreviation located just before the electrical unit and used as a short-cut in expressing numerical values. There are 5 common electrical prefixes, mega, kilo, milli, micro, and pico. Example: 7kV is equal to 7000V. prefix electrical unit
SCIENTIFIC NOTATION:	A method of expressing either very large or very small numbers by using a number between 1 and 9.999... times a power of 10. Example: 2.4×10^5 is equavalent to the number 240,000.

Remember these:

mega = M
kilo = k
basic unit•
milli = m
micro = μ
nano = n
pico = p

SCORE:

GRADE:

Name: ________________

Date: ________________

Period: ________________

WORKSHEET

VOCABULARY - SCRAMBLED WORD PUZZLE

Unscramble the letters below to uncover the terms.

EXAMPLE:

A.	AEXEPML	A.	EXAMPLE
1.	LOIK	1.	
2.	AGEM	2.	
3.	ONNA	3.	
4.	ILMLI	4.	
5.	IRMCO	5.	
6.	CPOI	6.	
7.	MOFURAL	7.	
8.	SINNOVRECO	8.	
9.	NETPONXE	9.	
10.	IERPXF	10.	
11.	SCBIA NUTI	11.	
12.	MCIEDLA TINOP	12.	
13.	IIICCFSTEN TATNNIOO	13.	
14.	WOPRE FO NET	14.	

SCORE:

GRADE:

Name: ______________

Date: ______________

Period: ______________

WORKSHEET

SCIENTIFIC NOTATION

1. In the number 4^3, the "3" is called an __________.	1.
2. When using exponents of the number 10, the exponent is often called a ________ __ _____	2.
3. What is the numerical value of the expression 3^3?	3.
4. To be in proper form, a scientific notation expression uses a number between A)__________ and B)__________ times ten to a power.	4A. 4B.
5. When converting the expression 7.6×10^{-3} to a regular number, the decimal point should be moved to the __________ three places.	5.

Convert the following numbers, expressed in scientific notation, into "regular" numbers.

	Figuring Space	
6. 5×10^2		6.
7. 4.65×10^4		7.
8. 5×10^{-3}		8.
9. 6×10^0		9.
10. 3.3×10^{-5}		10.
11. 9.5755×10^3		11.
12. 2.125×10^{-2}		12.

Convert the following "regular" numbers into a proper scientific notation expression.

	Figuring Space	
13. 300		13.
14. 650000		14.
15. .0083		15.
16. .100		16.
17. 7		17.
18. .000000000012		18.
19. .0015		19.
20. 386.5		20.

SCORE:
GRADE:

Name: __________________

Date: __________________

WORKSHEET

Period: __________________

MULTIPLICATION AND DIVISION USING SCIENTIFIC NOTATION

Complete the following problems show your work, and record your results in the answer boxes.

1.
$$\begin{array}{r} 5 \times 10^3 \\ \underline{\times \quad 2 \times 10^2} \end{array}$$

Convert to proper form

2.
$$\begin{array}{r} 52 \times 10^5 \\ \underline{\times \quad 11 \times 10^3} \end{array}$$

Convert to proper form

3.
$$\begin{array}{r} 3.6 \times 10^{-3} \\ \underline{\times \quad 5 \times 10^{-6}} \end{array}$$

Convert to proper form

4.
$$\begin{array}{r} 24 \times 10^{-12} \\ \underline{\times \ 1.2 \times 10^{6}} \end{array}$$

Convert to proper form

5.
$$\frac{42 \times 10^5}{2 \times 10^3}$$

Convert to proper form

6.
$$\frac{753 \times 10^3}{3 \times 10^{-3}}$$

Convert to proper form

7.
$$\frac{25 \times 10^{-9}}{4 \times 10^6}$$

Convert to proper form

8.
$$\frac{1.56 \times 10^{-6}}{13 \times 10^{-3}}$$

Convert to proper form

1. ☐
2. ☐
3. ☐
4. ☐
5. ☐
6. ☐
7. ☐
8. ☐

SCORE:

GRADE:

Name: ____________

Date: ____________

Period: ____________

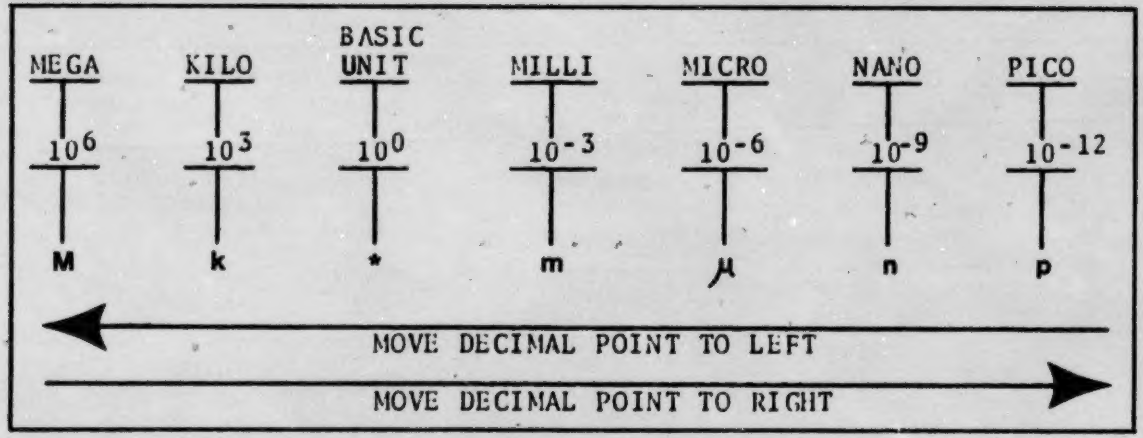
WORKSHEET

ELECTRICAL UNITS AND CONVERSIONS

Complete the chart below:

UNIT	ABBREVIATION	NUMERICAL POWER OF TEN	EQUIVALENT
MEGA			
	k		
BASIC UNIT			10^0
		.001	
			10^{-6}
NANO			
	p		

Use this conversion chart to help you perform electrical unit conversions.


MEGA
KILO
BASIC UNIT
MILLI
MICRO
NANO
PICO
10^6
10^3
10^0
10^{-3}
10^{-6}
10^{-9}
10^{-12}
M
k
*
m
μ
n
p
MOVE DECIMAL POINT TO LEFT
MOVE DECIMAL POINT TO RIGHT

Perform the following electrical unit conversions. Record your answers in the space provided, and in the answer box.

1. 27,000,000 ohms is the same as ________ megaohms. 1.
2. 1 kilovolt is the same as ________ volts. 2.
3. 2,000 milliamperes is the same as ________ amperes. 3.
4. .1 megaohms is the same as ________ ohms. 4.

Name: __________

Date: __________

Period: __________

5. 9 amperes is the same as __________ milliamperes. 5.
6. 600 millivolts is the same as __________ volts. 6.
7. 250 microamperes is the same as __________ amperes. 7.
8. 850 microvolts is the same as __________ milli volts. 8.
9. .115 amperes is the same as __________ milliamperes. 9.
10. 60 kilohms is the same as __________ megaohms. 10.
11. 90 ohms is the same as __________ kilohms. 11.
12. 49,000 picoamperes is the same as __________ microamperes. 12.
13. 5,000 microvolts is the same as __________ volts. 13.
14. 6 kilohms is the same as __________ ohms. 14.
15. .75 volts is the same as __________ microvolts. 15.
16. Convert 350,000Ω to kΩ. 16.
17. Convert .005A to mA. 17.
18. Convert .000061V to μV. 18.
19. Convert 485,000V to mV. 19.
20. Convert 75kΩ to Ω. 20.
21. Convert 153mA to μA. 21.
22. Convert 62pV to mV. 22.
23. Convert 560Ω to kΩ. 23.
24. Convert 150μA to A. 24.
25. Convert .09V to kV. 25.

SCORE:

GRADE:

Name: ______________________

Date: ______________________

Period: ______________________

WORKSHEET

QUEST ACTIVITY

"UNIT 20"

REVIEW OF BASIC MATHEMATICAL SKILLS

Do all work in the spaces provided. Show your work on this paper. Record your answers in the answer boxes.

1.

$$\begin{array}{r} 15 \\ 28 \\ 37 \\ +\ \ 47 \\ \hline \end{array}$$

2. $2.27 + .84 + 390 =$

1. ☐

2. ☐

3. $8 + 8.8 + 88 + .8 =$

4. The sum of x and y can be written as:

A) xy
B) $\frac{x}{y}$
C) $x-y$
D) $x + y$
E) none of these

3. ☐

4. ☐

5.

$$\begin{array}{r} 8\ 9\ 7\ 6 \\ -\ \ 4\ 7\ 3\ 5 \\ \hline \end{array}$$

6.

$$\begin{array}{r} 4\ 8\ 3\ 7 \\ -\ \ 2\ 5\ 4\ 8 \\ \hline \end{array}$$

5. ☐

6. ☐

7. $4.8 - 3.27 =$

8. Find the difference between 632 and 425.78.

7. ☐

8. ☐

Name: ____________

Date: ____________

Period: ____________

9. $\begin{array}{r} 73 \\ \times\ 61 \\ \hline \end{array}$

10. $\begin{array}{r} 2.08 \\ \times\ \ 2.3 \\ \hline \end{array}$

11. $\begin{array}{r} .3429 \\ \times\ \ 1000 \\ \hline \end{array}$

9. ____________

10. ____________

11. ____________

12. Which one of the following statements is true?

A) 6 x 4 = 21, B) 6 x 0 = 6, C) .6 x .4 = 2.4
D) 6 x 4 = 4 x 6, E) 6 x 4 = .24

12. ____________

In problems 13 - 16 write any remainders as fractions.

13. $\overline{)11095}$

14. $8416 \div 8$

15. $\frac{9612}{27}$

13. ____________

14. ____________

15. ____________

16. In the division, $6\,\overset{7}{\overline{)42}}$, the number 7 is called the:

A) divisor, B) dividend, C) quotient,
D) remainder, E) none of these.

16. ____________

17. $3\,\overline{).69}$

18. $.018\,\overline{)3.6}$

19. $.44\,\overline{)11}$

17. ____________

18. ____________

19. ____________

20. Which of the following cannot be done?

A) $32 \div 0$, B) $0 \div 14$, C) $27\,\overline{)0}$, D) $\frac{0}{7}$, E) all of these.

20. ____________

Name: ______________________

Date: ______________________

Period: ______________________

**In problems 21 - 28 reduce all fractions to lowest terms.

21. $\frac{1}{8} + \frac{1}{4} + \frac{3}{8} =$

22. $1\frac{1}{16} + \frac{3}{64} + 4\frac{17}{32} =$

21. ______

22. ______

23. $\frac{19}{64} - \frac{7}{32} =$

24. $19 - 2\frac{25}{64} =$

23. ______

24. ______

25. $\frac{2}{3} \times \frac{5}{8} =$

26. $1\frac{1}{4} \times 3\frac{1}{8} =$

25. ______

26. ______

27. $\frac{1}{8} \div \frac{3}{4} =$

28. $3\frac{2}{32} \div 1\frac{5}{64} =$

27. ______

28. ______

29. 4^3

30. $\sqrt{169}$

29. ______

30. ______

Name: ____________________

Date: ____________________

Period: ____________________

INFORMATIONAL HANDOUT

SCIENTIFIC NOTATION

Scientific notation is an easy, "short cut" method for expressing very large or very small numbers containing many zeros to either the right or left of the decimal point. Numbers such as 100,000,000 or .0000000025 can be easily shortened by writing them in scientific notation form. When multiplying or dividing with numbers containing many zeros, it is often difficult to keep track of the zeros and decimal points in order to arrive at a correct answer - scientific notation can help solve these types of problems too.

Let's look at an example of the "power" of scientific notation.

Try this problem:

15,000,000 X 6,200,000,000 = ?

If you used the standard multiplication method, your computations probably looked like this:

```
         6200000000
   x       15000000
   ----------------
         0000000000
        0000000000
       0000000000
      0000000000
     0000000000
    0000000000
  31000000000
  6200000000
  -----------------
  93000000000000000
```

But, using scientific notation, your problem would look like this:

$$\begin{array}{l} 6.2 \times 10^9 \\ \underline{1.5 \times 10^7} \\ 310 \\ \underline{62} \\ 9.30 \times 10^{16} \qquad \text{OR} \qquad 9.3 \times 10^{16} \end{array}$$

As you can see, scientific notation uses powers of 10 to replace the zeros in the "regular" number. Study the charts below, and see if you can find the relationship between the <u>exponent</u> of 10, and the decimal number.

Name: ____________________

Date: ____________________

Period: ____________________

POSITIVE POWERS OF 10

$10^0 = 1$

$10^1 = 10$

$10^2 = 100$

$10^3 = 1,000$

$10^4 = 10,000$

$10^5 = 100,000$

$10^6 = 1,000,000$

NEGATIVE POWERS OF 10

$10^0 = 1$

$10^{-1} = .1$

$10^{-2} = .01$

$10^{-3} = .001$

$10^{-4} = .0001$

$10^{-5} = .00001$

$10^{-6} = .000001$

You probably discovered that the exponent indicates how many places to move the decimal point. When using a positive power, the decimal point is moved to the right, while using a negative power will move the decimal point to the left.

Let's translate this knowledge into understanding scientific notation.

Scientific notation, in proper form, uses a number between 1 and 9.999... times a power of 10 as shown below:

$$\underset{\substack{\uparrow\\ \text{Number between 1 and 9.999...}}}{\underline{2.5}} \times \underset{\substack{\nwarrow\\ \text{Times a power of 10}}}{\underline{10}^{3}}$$

*CONVERTING SCIENTIFIC NOTATION INTO "REGULAR" NUMBERS

Using your knowledge of powers of ten it should be fairly simple to translate scientific notation into a "regular" number. For example: 2.5×10^3 is the same as 2500. Recall 10^3 means move the decimal 3 places to the right.

Rules:

(Scientific notation to a "regular" number)

1. If the scientific notation expression has a positive exponent, move the decimal point to the right the same number of places as the exponent.

Example:

$3 \times 10^4 = 3\underbrace{}.$ or 30000

Name: ____________________

Date: ____________________

Period: ____________________

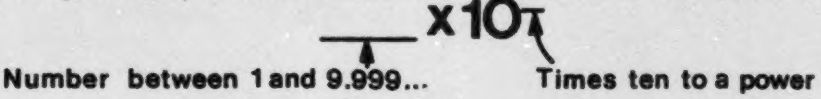
2. If the scientific notation expression has a negative exponent, move the decimal point to the left the same number of places as the exponent.

Example:

$2.1 \times 10^{-3} = \underbrace{.\ \ \ 2}{,}1$ or .0021

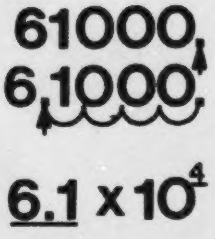
*CONVERTING REGULAR NUMBERS INTO SCIENTIFIC NOTATION EXPRESSIONS

Converting a number such as 61000 into scientific notation is a fairly simple job if you remember the basic form of a scientific notation number:



That is, a number between 1 and 9.999... times ten to a power (the power can be either positive or negative).

●Thus, when converting to scientific notation, move the decimal point of the original number until you get a number between 1 and 9.999.... Count the number of places you moved the decimal - this number will be your exponent.



1) Begin at the decimal point.

2) Move decimal point to here, (number between 1 and 9.999...) and count places moved.

3) Write in scientific notation form. (Drop extra zeros; exponent is equal to the number of decimal places moved).

Rules:

("Regular" number to scientific notation)

1. If the original number is greater than 1, then move the decimal point to the left until you have a number between 1 and 10. The exponent of ten is equal to the number of places the decimal point is moved and is given a positive sign.

Example: Convert 5600 to scientific notation

$5600 = 5\underbrace{.600}{.} = \underline{\underline{5.6 \times 10^3}}$

Name: ____________

Date: ____________

Period: ____________

2. If the original number is less than 1, then move the decimal point to the right until you have a number between 1 and 10. The exponent of ten is equal to the number of places the decimal point is moved and given a negative sign.

Example: Convert .00034 to scientific notation.

$.00034 = 0003.4 = \underline{3.4 \times 10^{-4}}$

* MULTIPLICATION USING SCIENTIFIC NOTATION

Using scientific notation when multiplying or dividing greatly simplifie the job since you do not have to keep track of zeros or the number of decimal places; plus its easy.

Look at this example and see if you can catch what is being done:

$$\begin{array}{r} 4 \times 10^{3} \\ \underline{\times\ 2 \times 10^{4}} \\ 8 \times 10^{7} \end{array}$$

That's it - to multiply using scientific notation simply multiply the "numbers" together and add the exponents. (Watch the signs of the exponents).

Here are some other examples:

A)
$$\begin{array}{r} 3 \times 10^{4} \\ \underline{\times\ 7 \times 10^{-3}} \\ 21 \times 10^{1} \end{array}$$

OR

(2.1×10^{2})

B)
$$\begin{array}{r} 2 \times 10^{-2} \\ \underline{\times\ 8 \times 10^{-1}} \\ 16 \times 10^{-3} \end{array}$$

OR

(1.6×10^{-2})

C)
$$\begin{array}{r} 4.1 \times 10^{-6} \\ \underline{\times\ \ 5 \times 10^{4}} \\ 20.5 \times 10^{-2} \end{array}$$

OR

(2.05×10^{-1})

* DIVISION USING SCIENTIFIC NOTATION

Dividing using scientific notation is almost as simple. See if you can figure out the system by studying this example.

$$\frac{8 \times 10^{5}}{2 \times 10^{2}} = 4 \times 10^{3}$$

Name: ______________________

Date: ______________________

Period: ______________________

Did you understand that one? To divide, write the expressions as a fraction. Divide the numbers as you normally would, then change the sign of the exponent on the bottom, and add it to the exponent on the top.

Here are some more examples:

A) $$\frac{15 \times 10^{6}}{3 \times 10^{4}} = \boxed{\frac{15}{3}} = 5 \times \boxed{10^{\begin{array}{r}+6\\ -4\\ \hline 2\end{array}}} = 5 \times 10^{2}$$

B) $$\frac{14 \times 10^{-3}}{7 \times 10^{2}} = \boxed{\frac{14}{7}} = 2 \times \boxed{10^{\begin{array}{r}-3\\ -2\\ \hline -5\end{array}}} = 2 \times 10^{-5}$$

C) $$\frac{25 \times 10^{1}}{5 \times 10^{-3}} = \boxed{\frac{25}{5}} = 5 \times \boxed{10^{\begin{array}{r}1\\ +3\\ \hline 4\end{array}}} = 5 \times 10^{4}$$

D) $$\frac{36 \times 10^{-4}}{4 \times 10^{-2}} = \boxed{\frac{36}{4}} = 9 \times \boxed{10^{\begin{array}{r}-4\\ +2\\ \hline -2\end{array}}} = 9 \times 10^{-2}$$

Simple!

Name: ________________

Date: ________________

Period: ________________

INFORMATIONAL HANDOUT

CONVERSION OF ELECTRICAL UNITS

There are six common prefixes or subunits used with electrical measurements. These units, (mega, kilo, milli, micro, nano, and pico) provide a simple method for expressing very large or very small numbers without having to use scientific notation. Study the chart below and learn the meaning and relationship between the various units.

PREFIX	ABBREVIATION	POWER OF 10 EQUIVALENT	NUMBERICAL VALUE
Mega	M	10^6	1,000,000
Kilo	k	10^3	1,000
Basic Unit (volts, amps, ohms, etc.)		10^0	1
Milli	m	10^{-3}	.001
Micro	μ	10^{-6}	.000001
Nano	n	10^{-9}	.000000001
Pico	p	10^{-12}	.000000000001

Thus; 1M is equal to 1×10^6 or 1,000,000.

2kV is the same as 2×10^3V or 2,000V.

3mA can be written as 3×10^{-3}A or .003A.

4μV is equal to 4×10^{-6}V or .000004V.

5nA is the same as 5×10^{-9}A or .000000005A.

6pV can be written as 6×10^{-12}V or .000000000006V.

Often times it is necessary to convert from one electrical unit to another, especially when working with basic electrical formulas which require the electrical quantities to be in basic unit, or similar units (all in milli, micro, etc.).

Name: ____________ ____

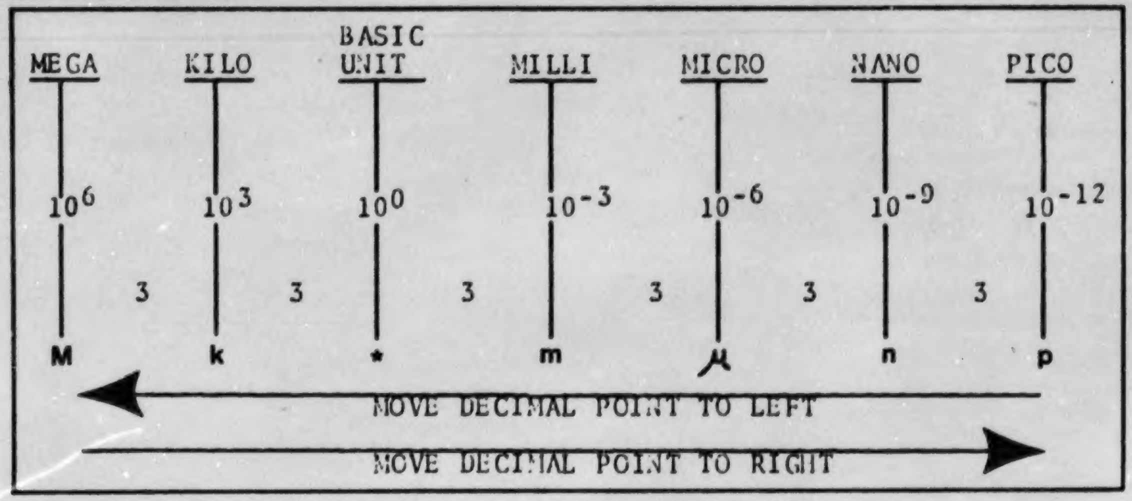
Date: ______________

Period: ______________

How would you convert 3kV to basic unit, or volts? Well, if you recall that kilo means thousand or 10^3, then it's easy to see that 3kV = 3 x 10^3 volts or 3000V. So actually, all that was done to convert from kilo to base was to move the decimal point 3 places to the right (3kV = 3⌣⌣⌣ = 3000V). Likewise, if you are asked to change 3000V to kilo volts, all that need be done is to move the decimal point 3 places to the left. (3000V = 3⌣⌣⌣ = 3kV).
Thus, the process of converting from one electrical unit to another simply involves moving the decimal point to the left or to the right a certain number of places.

The chart below can be used as an aid in performing electrical unit conversions. Notice that between each unit there are three decimal places.

CONVERSION CHART:



Steps in using the conversion chart:

When converting from one unit to another:

1) Count the number of decimal places from the "original" unit to the "desired" unit. (Remember, there are 3 decimal places between each unit).

2) Determine the direction the decimal point will move. The decimal point will be moved in the same direction that you read across the chart, from your original unit to your final unit. For example, if you are converting from kilo to milli the decimal point will be moved to the right, but if you were converting from micro to basic unit the decimal point will be moved to the left.

3) Move the decimal point the number of places counted in step 1, and in the direction determined in step 2.

Name: ____________________

Date: ____________________

Period: ____________________

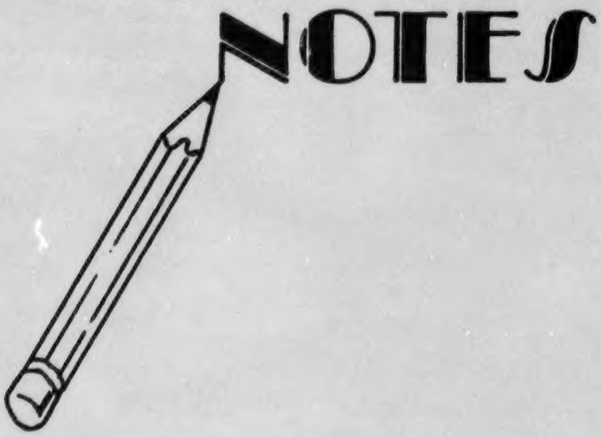
SAMPLE CONVERSIONS:

A. "25000 ohms is the same as __________ kilohms."
The question is asking you to convert 25000 ohms (basic unit) to kilohms (kilo). Looking at the chart; count the number of decimal places between basic unit and kilo. You should have come up with 3 decimal places. When counting, you started at "basic unit", and moved to kilo, which took you to the left across the chart; thus, you will move the decimal point to the left. With this information let's complete the conversion - - -

$25000\Omega = 25_{\wedge}\underbrace{000}, = \underline{25k\Omega}$

B. "Convert .007A to __________ mA"
Procedure: Move from basic unit (A) to milli which is 3 places to the right across the chart. Thus: $.007A = .\underbrace{007}_{\wedge} = \underline{7mA}$.

C. "Convert 4.3μV to __________ kV"
Procedure: Move from μ to k across the chart, which is 9 decimal places to the left. Thus: $4.3\mu V = {}_{\wedge}\underbrace{000000004},3 = \underline{.0000000043kV}$.



Name: ____________________

Date: ____________________

Period: ____________________

INFORMATIONAL HANDOUT

INTRODUCTION TO MATHEMATICAL FORMULAS

$$y = \frac{10 + z}{A}$$

The statement above is a mathematical formula. It tells how to obtain a desired result from a mixture of numbers and terms.

You might think of a formula as a mathematical recipe. That is, by properly combining different ingredients together (numbers, operations, or variables) you will arrive at the desired result - a correct answer.

A formula then, tells you what to do -- a mathematical formula tells you for example, when to add, subtract, multiply or divide.

Formulas can be simple statements such as $y = 10 + 6$ (which means to find the value of y, add 10 and 6) or very complex expressions such as $R = 7A^2 + 6A - 10$ (meaning to find the value of R; first square the value of A, multiply that by 7, add the result to 6 times A, and finally subtract 10).

Whether a formula is simple or complex they have many things in common:

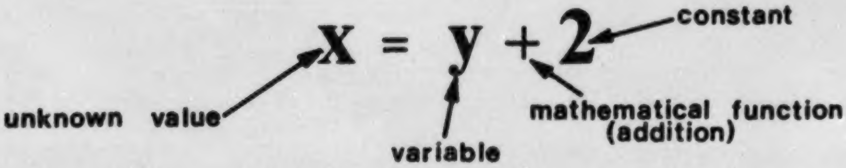
1) Unknown value: Generally abbreviated with a letter, and located by itself on the left side of the equal sign. This is the value you are trying to find.

2) Variable: A number, also abbreviated as a letter, but located on the right side of the equal sign. A variable can be assigned many different values.

3) Constant: A number with a fixed value.

4) Mathematical Function: The mathematical operation to be performed, such as multiplication, division, addition, or subtraction.

EXAMPLE:



Name: ______________________

Date: ______________________

Period: ______________________

USING MATHEMATICAL FORMULAS:

Study the sample problems below, they will explain how to use a simple formula.

1. Solve for "R" in the formula below, given that $y = 6$.

$R = 4 + y$

Step 1. Substitute the "given" value of y into the formula.

$R = 4 + \underline{6}$

Step 2. Perform the mathematical function - addition.

$R = 10$

Step 3. Record the solution.

$R = \boxed{10}$

2. Solve for "Q" in the formula below, given that $S = 10$ and $D = 5$.

$Q = 2 \times S + D$

Step 1. Substitute the given values of "S" and "D" into the formula.

$Q = 2 \times \underline{10} + \underline{5}$

Step 2. Perform the multiplication.

$Q = 20 + 5$

Step 3. Perform the addition.

$Q = 25$

Step 4. Record the solution.

$Q = \boxed{25}$

*Try this one on your own.

3. Solve for "E" in the formula below, given that $I = 5$ and $R = 100$.

$E = I \times R$

Step 1. ______________________________________

____

____

E =

E =

$E = \boxed{}$

Step 2. ______________________________________

____

____

Step 3. ______________________________________

____

____

ANSWER: 500

SCORE:	
GRADE:	

Name: ______________

Date: ______________

Period: ______________

ANSWER SHEET

EXAM LII-U20

	T A	F B	C	D		T A	F B	C	D		T A	F B	C	D		T A	F B	C	D
1.	■				26.					51.					76.				
2.		■			27.					52.					77.				
3.		■			28.					53.					78.				
4.	■				29.					54.					79.				
5.	■				30.					55.					80.				
6.	■				31.					56.					81.				
7.		■			32.					57.					82.				
8.	■				33.					58.					83.				
9.		■			34.					59.					84.				
10.		■			35.					60.					85.				
11.	457				36.					61.					86.				
12.	.0073				37.					62.					87.				
13.	2.5				38.					63.					88.				
14.	5.6×10^5				39.					64.					89.				
15.	8.9×10^{-3}				40.					65.					90.				
16.	5.55×10^2				41.					66.					91.				
17.	1.24×10^4				42.					67.					92.				
18.	1.3×10^{10}				43.					68.					93.				
19.	2.5K ohms				44.					69.					94.				
20.	5 mA				45.					70.					95.				
21.	.00045V				46.					71.					96.				
22.	.0089 μA				47.					72.					97.				
23.	600000 Ω				48.					73.					98.				
24.	.02V				49.					74.					99.				
25.	y = 15				50.					75.					100.				

*Show work for problems on back of answer sheet.

ANSWER KEY
UNIT 20

A. SCRAMBLED WORD PUZZLE

1. kilo
2. mega
3. nano
4. milli
5. micro
6. pico
7. formula
8. conversion
9. exponent
10. prefix
11. basic unit
12. decimal point
13. scientific notation
14. power of ten

B. SCIENTIFIC NOTATION

1. exponent
2. power of ten
3. 27

4A. 1

4B. 9.999

5. left
6. 500
7. 46500
8. .005
9. 6
10. .000033
11. 9575.5
12. .02125
13. 3×10^{2}
14. 6.5×10^{5}
15. 8.3×10^{-3}
16. 1×10^{-1}
17. 7×10^{0}
18. 1.2×10^{-11}
19. 1.5×10^{-3}
20. 3.865×10^{2}

C. MULTIPLICATION AND DIVISION USING SCIENTIFIC NOTATION

1. 1×10^{6}
2. 5.72×10^{10}
3. 1.8×10^{-8}
4. 2.88×10^{-5}
5. 2.1×10^{3}
6. 2.51×10^{8}
7. 6.25×10^{-15}
8. 1.2×10^{-4}

D. ELECTRICAL UNITS AND CONVERSIONS

1. 27
2. 1000
3. 2
4. 100,000
5. 9000
6. .6
7. .00025
8. .85
9. 115
10. .06
11. .09
12. .000000062mV
13. .005
14. 6000
15. 750,000
16. 350 k
17. 5 mA
18. 61μV
19. 485,000,000 mV
20. 75,000 ohms
21. 153,000 μA
22. .000062 mV
23. .56 k ohms
24. .00015 A
25. .00009 kV

E. QUEST ACTIVITY

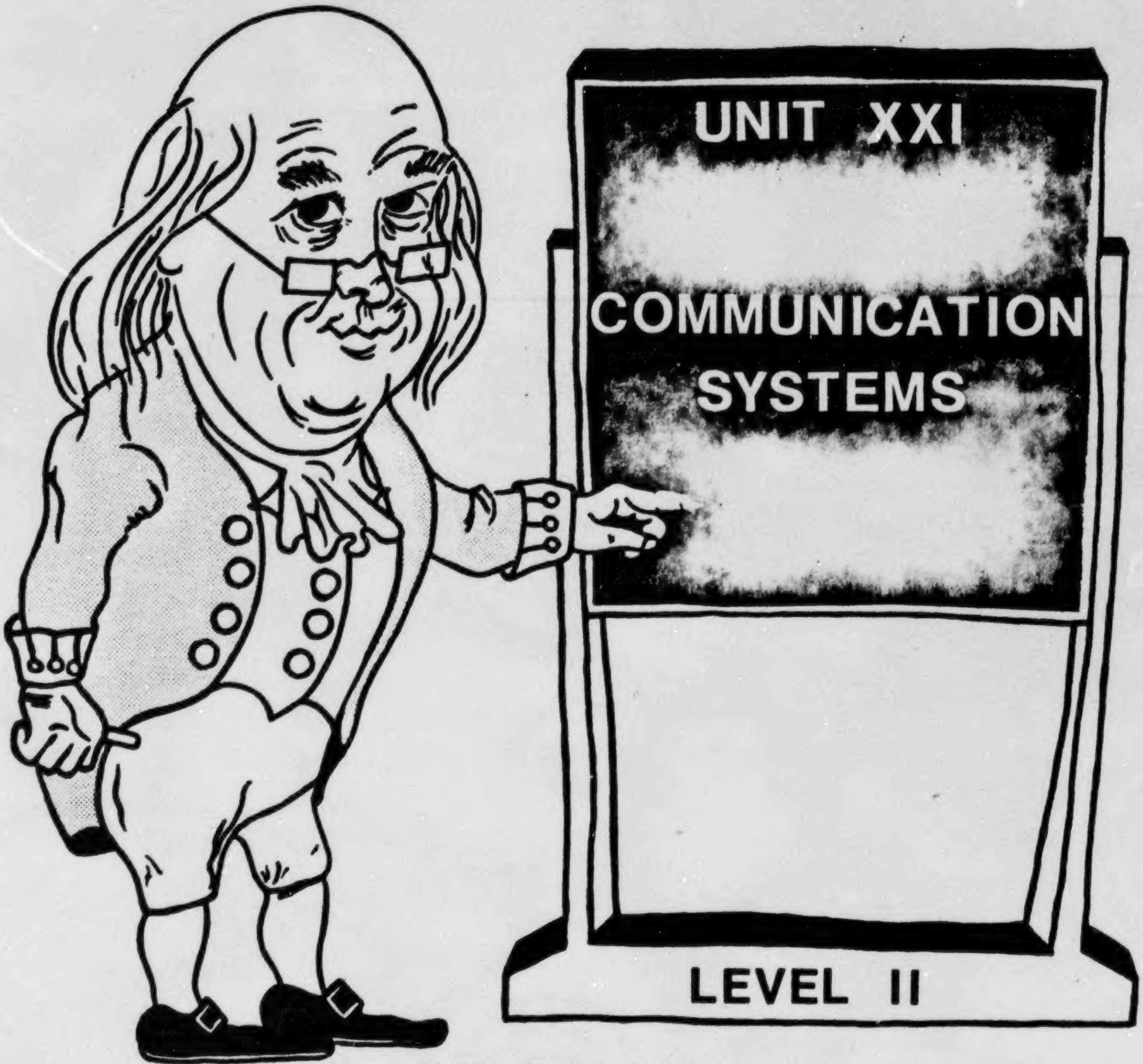
1. 127
2. 393.11
3. 105.6
4. D
5. 4241
6. 2289
7. 1.53
8. 206.22
9. 4453
10. 4.784
11. 342.9
12. D
13. 236 3/47
14. 1052
15. 356
16. C
17. .23
18. 200
19. 25
20. A
21. 6/8 or 3/4
22. 5 41/64
23. 5/64

ANSWER KEY UNIT 20
(continued)

24. 16 39/64
25. 10/24 or 5/12
26. 3 29/32
27. 4/24 or 1/6
28. 2 58/69
29. 64
30. 13

ELECTRICITY / ELECTRONICS

CURRICULUM GUIDE
INSTRUCTIONAL MODULE


UNIT XXI
COMMUNICATION SYSTEMS
LEVEL II

STATE OF CALIFORNIA
DEPARTMENT OF EDUCATION

NAME________________________
DATE STARTED______________
DATE COMPLETED__________

BY
R. E. LILLO
N. S. SOFFIOTTO

Title of Unit: **Communication Systems**

Time Allocation: **2 weeks**

Unit Goal:

To achieve student competence in perceiving a general overview of the importance and purpose of basic communication systems.

Unit Objectives:

The student will be able to:

1. explain the necessity for early man's desire to communicate with others, and describe a variety of ancient long distance communication systems.
2. identify nine fundamental communication systems and briefly indicate the general method of operation.
3. Summarize the sequence of elements or processes that are involved in any basic communication system.

Evaluation:

The student will demonstrate his/her competence in terms of these measurable objectives based upon individual instructors acceptable performance criteria, which many utilize a combination of written, oral, and laboratory testing procedures.

Instructor References:

Electronic Communication. Robert L. Shrader, McGraw-Hill Book Co., 1975. Chapters: 16-20, 24-28, and 33.

Exploring Electricity Electronics With the Electrical Team. Philip J. Rollain and Thomas E. Kraus, Delmar Publishers, 1978. Unit: 23.

Understanding Electricity and Electronics. Peter Buban and Marshall L. Schmitt, McGraw-Hill Book Co., 1975. Units: 36-43.

Overview:

Unit 21 is presented as the last technical unit of this level, and its main purpose is to be informative. In depth technical topic coverage which may not be presented in this unit is dedicated for presentation at a more appropriate time conceptionally.

Preface the individual system topics with an overview on the evolution of communication. Then, present the essential components that are in the communication process. This would include the message source, coder, carry decoder, and message destination.

Next, work through each topic title in the unit and deliver a brief explanation of that system's operation, and note that these topics should be covered in a manner that will promote general technical understanding.

A variety of appropriate exercises and laboratory experiments and/or projects should be coordinated with all unit topics when feasible.

Suggested Presentation Hints/Methodology:

Follow the instructional module unit outline as a basic skeleton for curriculum presentation, however, note the following:

1. This unit was also included to provide student motivation to continue their studies, so do not bear down excessively in terms of technical specifics, but instead stress concepts with emphasi on the application of each type of communication system.
2. When discussing the first long distance communication system (telegraph) it might be helpful to relate its operation in relationship to the elements contained in any communication system. (Message-source, key-coder, wire-carry, sounder-decoder and operator-destination) use this technique for each system topic discussed.
3. This unit provides an ideal time to explain the purpose of the Federal Communication Commission (FCC). Relate that this is a governmental agency that regulates all U.S.A. "wave" transmission. Have the class explain why such an agency might be necessary.
4. The topic of computer as a system within the chain of communication devices is obvious. However, present these additional discussion areas and some interesting conversations will ensue:
    People communicating with computers
    Computers communicating with people
    Computers communicating with other computers

Supplemental Activities and Demonstrations:

1. Write the National Aeronautics and Space Administration (NASA). NASA educational and informational publications systems are designed to meet the needs of both students and educators. A listing of their materials and cost can be ordered from:

    Superintendent of Documents
    U.S. Government Printing Office
    Wahington, D.C. 20402
2. Have students make a poster depicting one or more of the communication systems discussed. Display the posters.
3. Emphasize that interference can disrupt even the most sophisticated communication system. Place a buzzer close to a TV and activate both shile observing the TV screen, then discuss.

Instructional Module Contents:

1. Unit Outline (overhead)
2. Pre-Post Test (keyed)
3. Technical Glossary
4. Worksheet (vocabulary) - Know Your Definitions
5. Worksheet - Communication Systems
6. Quest Activities
7. Informational Handout (Communication Systems)
8. Unit Module Answer Keys

XXI. Communication Systems

A. Evolution of Communication Systems

B. Telegraph

C. Telephone

D. Radio

E. Television

F. Radar

G. Microwave

H. Satellites

I. Lasers

J. Computers

Test Number _____

LII-U21

UNIT EXAM

COMMUNICATION SYSTEMS

IMPORTANT-

Indicate your responses on the answer sheet only. Fill in the box corresponding to the correct answer to each question - there is only one correct answer for each question.

1. The person who begins the communication process or system is called the message or informational source. (T-F)

2. There are five basic parts or elements of a communication system. (T-F)

3. A telegraph key is a communication device that translates electric pulses into mechanical action. (T-F)

4. A television receiver is a communication device in which visual images are translated into electric current. (T-F)

5. The decoding element of a communication system changes data or information into a form that is meaningful to the message destination user. (T-F)

6. An audio reproducer is the technical name for a microphone. (T-F)

7. V. Zworykin, an American physicist, was one of the developers of the television communication system. (T-F)

8. A house antenna is a very important element in a cable television receiver system. (T-F)

9. The letters F.C.C. are an abbreviation for a noncommercial radio station in Washington D.C. (T-F)

10. A radar system will transmit signals that can strike an object and bounce off, thus creating a receivable echo. (T-F)

11. How many transmitters are utilized in a television broadcasting station.
(A) 1, (B) 2, (C) 3, (D) 4.

12. A laser beam is usually considered a brilliant-red beam of __________ light.
(A) electromagnetic, (B) infrared, (C) coherent, (D) incoherent.

13. The __________ stage of a computer holds information for future processing.
(A) storage, (B) logic, (C) control, (D) output.

14. Radio waves will travel at __________, and they travel in every direction from an antenna.
(A) the speed of sound, (B) about 50 to 200 m.p.h., (C) 600,000 hertz, (D) 186,000 m.p.s.

15. The first satellite was launched by the Russians and called __________.
(A) "Beatnik", (B) "Spacenik", (C) "Sputnik", (D) "Firstnik".

16. When a television transmitter and receiver are locked in step, the phrase which expresses this is; "they are __________."

17. Satellites generally generate their own operating power from __________ energy, however, power demands are not really that great because the ground radio receiving stations are now so sensitive and accurate that only a small signal need be transmitted.

18. Two of the human senses used in the communications process between people are speaking and __________.

19. In telegraph communication, the process of attaching meaning to dots and dashes heard from the decoder element is the function of the __________ element.

20. __________ commercial broadcast stations operate on a band of frequencies from 535 kHz to 1605 kHz.

Name: ____________________

Date: ____________________

Period: ____________________

TECHNICAL GLOSSARY

ANTENNA:	A device, made up of a pattern of wires or conducting rods, used to either send (radiate) or pick-up (receive) radio waves.
CARRY:	The medium or device used to move or carry information from one location to another. In a radio system, for example, the "carry" is high frequency AC waves or radio waves.
CODER:	A device or circuit used to shape or convert information into the proper form for transmission.
COMMUNICATION:	The process of sending (transmitting) and acquiring (receiving) understandable information.
COMPUTER:	An electric device able to accept information, process or work on that information and supply data or results. A computer usually consists of an input and output device, storage or memory circuits, arithmetic/logic units, and a control unit.
DATA:	A term used to describe information, facts or figures.
DECODER:	A device or circuit used to separate the "information" from the "carry" of a transmitted signal. The decoder reproduces the original message.
DETECTION:	The process of separating the "intellegence or information from the "carry" in a communication system.
INFORMATION:	The facts, data, programming, or intellegence added to the carry to make up a transmitted signal.
LASER:	An electronic device which emits a tight beam of light that is extremely intense and highly directional. Lasers can be used to cut materials, align items in a straight line, measure distances, and communicate.
MICROWAVE:	Extremely short length, ultra high frequency radio wave which travels at the speed of light and in a straight line. Microwaves can be used to carry information as well as to heat and cook food.
MODULATION:	The process of mixing the "intellegence or information" with the "carry" in preparation for transmission.
RADAR:	A transmission system using bursts of high frequency electrical energy at a set frequency, duration, and direction. If the projected wave strikes an object an "echo" is sent back which is used to determine the location and distance of the object.

Name: ____________________

Date: ____________________

Period: ____________________

RADIO:	A communication system using radio waves of a set frequency to carry information from the transmitter to an antenna, through the air waves to a receiving antenna, and finally to the receiver and listener. Radio was the first wireless communication system able to transmit and receive voice signals.
RADIO WAVE:	High frequency electrical energy capable of traveling great distances through the air and also able to carry information. Radio frequency (RF) waves range from 20,000 cycles per second to 30,000,000,000 cycles per second.
SATELLITE:	An automated spacecraft able to perform specific jobs while orbiting around the earth. Basically, satellites are able to gather information, process that information, and transmit and receive data.
SYNC:	The process of timing or setting two or more actions to occur at the same instant. For example, in a television system the sound and picture signals must be in sync to coordinate voice and mouth movements or sound with actions.
TELEGRAPH:	An early communication system using a wire to carry electrical pulses from one location to another. A "key" is used to produce and transmit a series of pulses (dots and dashes) which are received and reproduced by a "sounder." The operator must then translate the coded message into understandable language.
TELEPHONE:	A practicle communication system able to transmit and receive voice and sound signals by means of electrical impluses traveling through interconnecting wires. The transmitting device is a microphone located in the mouthpiece of the hand set, while the receiving device consists of a vibrating diaphragm located in the earpiece.
TELEVISION:	Generally, a wireless communication system which is capable of transmitting simultaneously, video (picture) and audio (sound) signals on a radio wave carry. When the TV signal is captured by the receiving antenna and fed to the receiver, it is converted back to visual pictures with synchronized sound.

SCORE:

GRADE:

Name: ____________________

Date: ____________________

Period: ____________________

WORKSHEET

VOCABULARY - KNOW YOUR DEFINITIONS

Below you will find short definitions for a number of electrical terms. Your job is to find the term that best fits the definition. If you're imaginative you might refer to your technical glossary.

	DEFINITION		TERM
EXAMPLE:			
A.	The basic unit for measuring current.	A.	AMPERE
YOUR TURN:			
1.	The process of transmitting and receiving understandable information.	1.	
2.	A device or circuit used to separate the information from the signal carry.	2.	
3.	A system using bursts of electrical energy to determine location and distance of an object.	3.	
4.	High frequency electrical energy capable of carrying information through the air great distances.	4.	
5.	A system of communication using both video and audio signals carried by radio waves.	5.	
6.	The process of timing two actions to occur at the same instant.	6.	
7.	The medium or device used to move information from one location to another.	7.	
8.	The process of mixing the signal information with the carry.	8.	
9.	A device which produces an extremely intense, highly directional, tight beam of light.	9.	
10.	A communication system capable of sending information over a wire in the form of electrical pulses (dots and dashes).	10.	
11.	The facts, data, programing or intellegence added to the carry.	11.	
12.	Extremely short, ultrahigh frequency radio waves which travel at the speed of light and in a straight line.	12.	

SCORE:	
GRADE:	

Name: ____________________

Date: ____________________

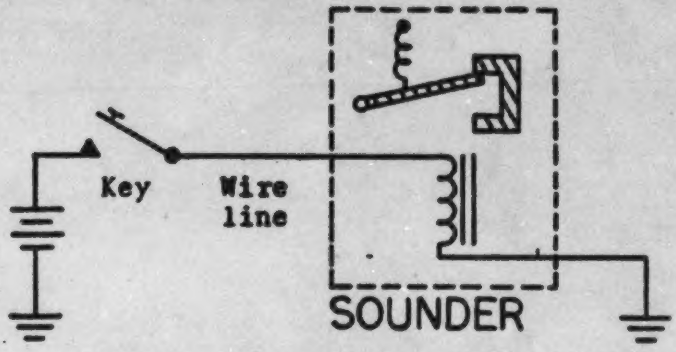
Period: ____________________

WORKSHEET

COMMUNICATION SYSTEMS

Communication plays a vital role in our existance. The systems developed to transmit information from person to person are consistently being improved, modified, or replaced with a more efficient process. Modern day communication systems employ techniques such as radio wave, microwave, and laser-light beam transmission. Below is the beginning of a description on communication systems which you are to complete and document. Follow the example given below and include a sketch or a block diagram of each system when possible along with the communication system elements.

A Telegraph System-(Example)



Facts	System and Inventors(s):	Telegraph system patented 1843 by Samuel Morse.
	Basic Operation:	Hand operated switch (key) controls pulses of current (dots and dashes) which are assigned alphanumeric meaning.
Communication ystem Elements	Source:	Message content.
	Coder:	Telegraph key.
	Message Carrier:	Wire/electricity.
	Decoder:	Telegraph sounder.
	Message Destination:	Electrical pulses converted to sound waves and received by human ear and translated by brain applying Morse Code knowledge (person receiving).

Name: ____________________

Date: ____________________

Period: ____________________

B **Radar System:**

Source: Coder: Carrier: Decoder: Destination:	FACTS:

- -

C **Laser System-**

Source: Coder: Carrier Decoder: Destination:	FACTS:

- -

Name: ____________________

Date: ____________________

Period: ____________________

D **Television System**

Source: **Coder:** **Carrier:** **Decoder:** **Destination:**	**FACTS:**

- -

E **Microwave System-**

Source: **Coder:** **Carrier:** **Decoder:** **Destination:**	**FACTS:**

- -

SCORE:

GRADE:

Name: ____________

Date: ____________

Period: ____________

WORKSHEET

QUEST ACTIVITY

"UNIT 21"

Utilizing the biographical clues below, identify this individual. Your school library or just an Encyclopedia can serve as an important resource.

Fill in the names of the books used to solve this "Quest Activity":

1. ____________
2. ____________
3. ____________

WHO AM I...

* * *

- Moved to the U.S.A. in 1920
- Developed the iconoscope tube
- Born in 1889
- Physicist
- Worked for RCA.
- Attended Petrograd Institute of Technology
- Pioneer in the discovery of TV
- Worked for Westinghouse
- Inventor/Engineer
- Assisted in the Development of the "Electron Microscope"
- Holds over 120 patents
- Received the National Medal of Science Award
- Raised in Russia
- Created the Kinescope

MY NAME IS.....

____________ ____________

Name: ____________________

Date: ____________________

Period: ____________________

INFORMATIONAL HANDOUT

COMMUNICATION SYSTEMS

BACKGROUND:

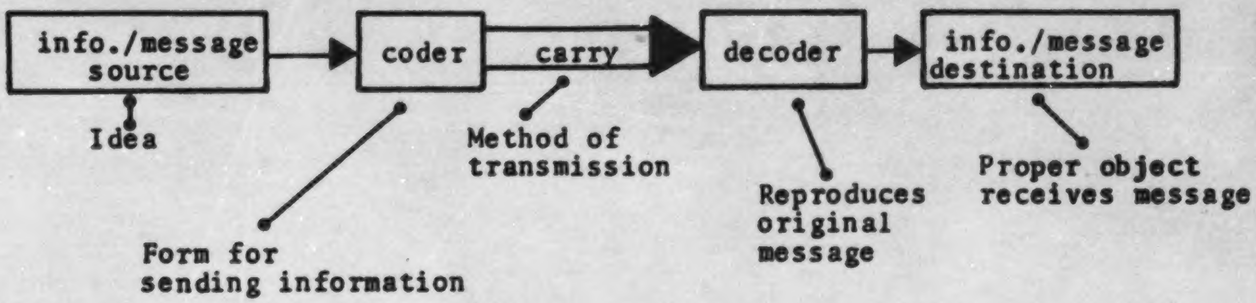
Without communication we cannot survive. A baby must communicate its need for air, food, etc. from the moment it gets life........................and there begins a fantastic process requiring communication at every step.

1 Communication: the process of giving and receiving information.

"Con-munio" (Latin word)

→ to transmit information.

2 Parts of a communication system.


info./message source
coder
carry
decoder
info./message destination
Idea
Method of transmission
Form for sending information
Reproduces original message
Proper object receives message

EARLY HISTORY:

Cave dwellers felt the need to communicate almost immediately and some early systems for communication were grunts and gestures. People joined together and formed tribes and communities and again they had to develop sounds (language). Many years passed before communication systems were able to transmit over great distances.

TELEGRAPH:

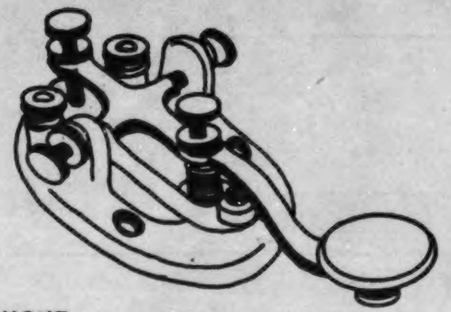
This system opened the door for long distance communication. Samuel Morse in 1835 invented the telegraph which is a method of sending and receiving messages by pulses (dots and dashes). The operator touches rhythmically, a device called a key, and then an electrical wire transmits the pulses to a sounder which clicks in the same manner. The clicks (dots and dashes) correspond to a specific code that represents letters from the alphabet.

Name: ____________________

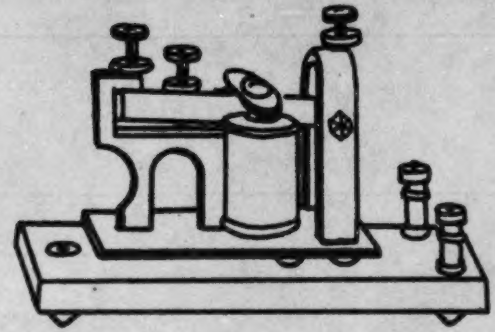
Date: ____________________

Period: ____________________

KEY

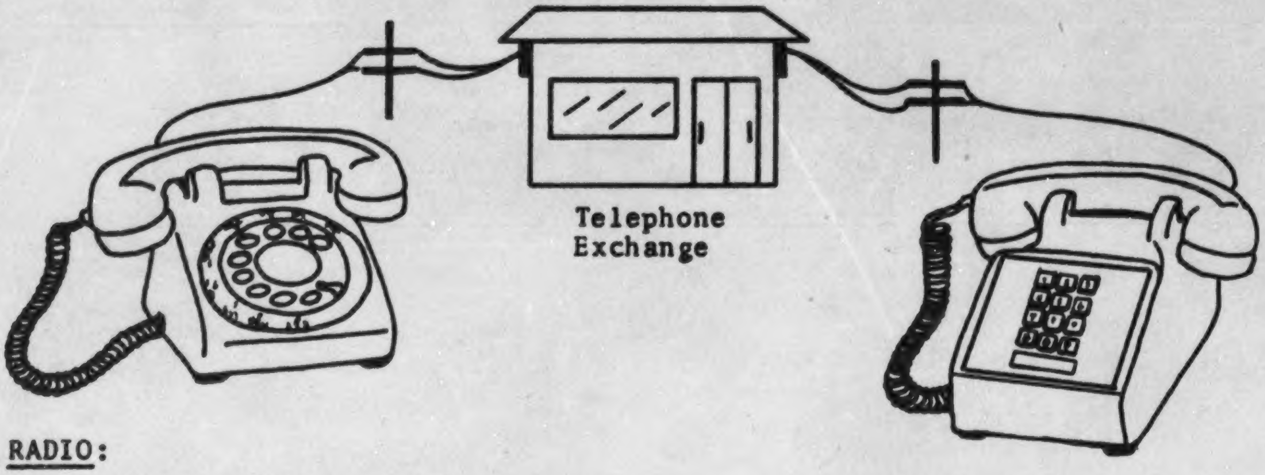


SOUNDER



TELEPHONE:

This system is used by the average person generally on a daily basis. It was invented by Alexander G. Bell and he patented the telephone in 1876. A telephone is simply a transmitter (mouthpiece) connected to a receiver (earpiece) by electrical wires. Specifically, sound causes a diaphragm to compress small carbon particles in the mouthpiece. Then the varying pressure controls and electricity to an electromagnet in the earpiece. This electromagnet causes the earpiece diaphragm to vibrate and in turn we hear a voice that sounds just like that person



RADIO:

During the early 1900's various kinds of vacuum tubes that could be used to detect and amplify radio signals were created. The development of such tubes led to the invention of radio equipment for transmitting and receivin sound. Most electronic people give credit to Reginald Fessenden of the U.S.A. for the first radio broadcast.

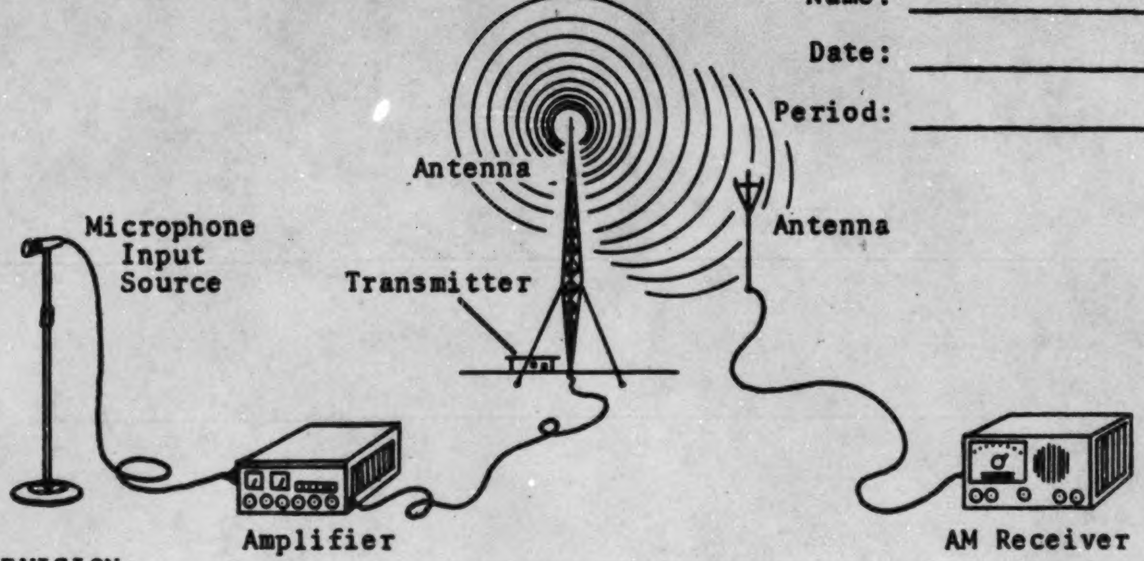
The radio transmitter made it possible to send the information with the aid of an antenna tower. The radio wave travels through the air where the signal is picked up by a radio receiver.

Other radio communication systems would include FM, and stereophonic systems.

Name: ______________________

Date: ______________________

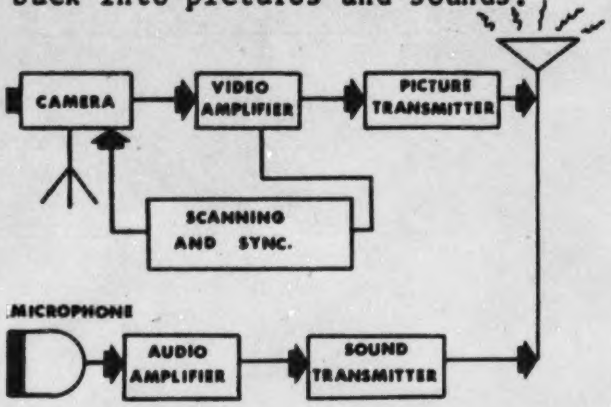
Period: ______________________


Antenna
Microphone Input Source
Transmitter
Antenna
Amplifier
AM Receiver

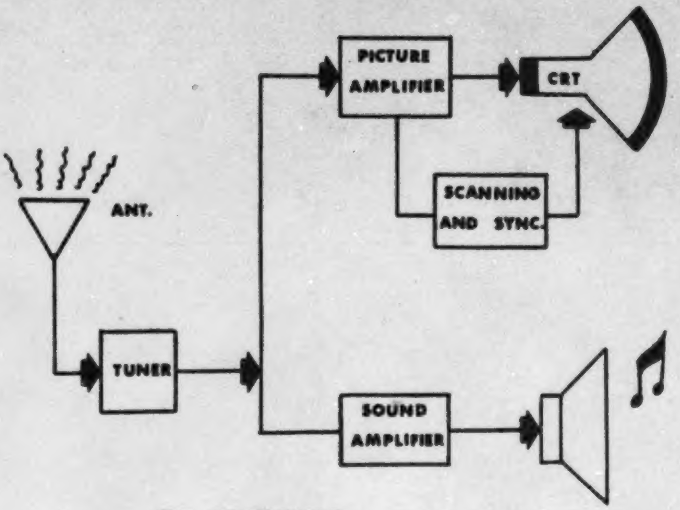
TELEVISION:

A system of communication which combines the sending and receiving of sound (audio) and image (video) signals. Vladmir Zworykin, John Baird, Charles Jenkins and others are credited with its development in the 1920's.

Most pictures and sounds received by a television set are beamed from a television station (camera, studio, equipment, etc.) on electronic signals called "electromagnetic waves." The television set converts these waves back into pictures and sounds.


CAMERA
VIDEO AMPLIFIER
PICTURE TRANSMITTER
SCANNING AND SYNC.
MICROPHONE
AUDIO AMPLIFIER
SOUND TRANSMITTER

TV TRANSMITTER


PICTURE AMPLIFIER
CRT
SCANNING AND SYNC.
ANT.
TUNER
SOUND AMPLIFIER

TV RECEIVER

RADAR:

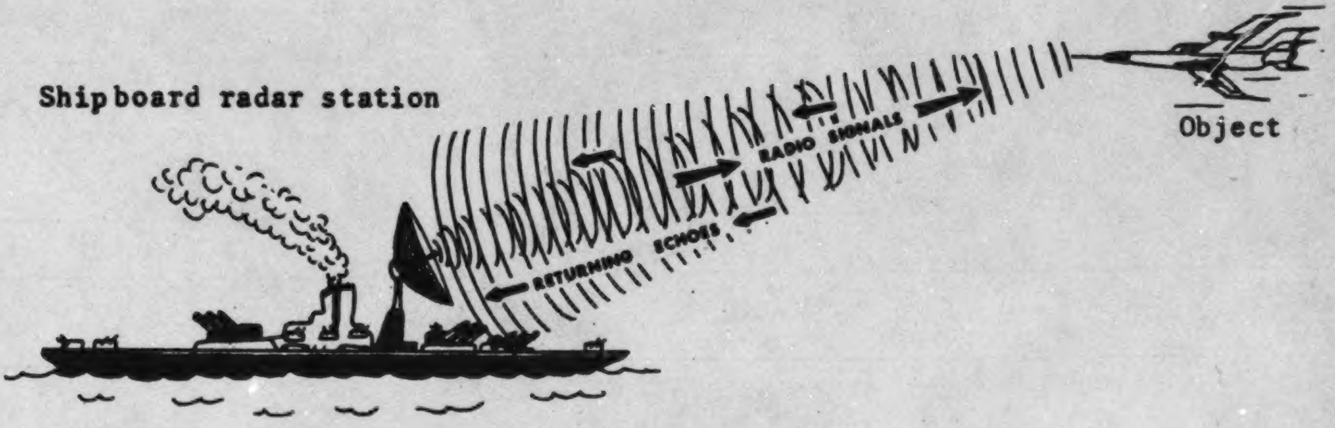
This system is utilized in navigational work and in detection of objects at a distance.

The discovery of the radar concept is attributed to L.C. Yound and A.H. Taylor, in 1922. A simple radar system consist of an aimed antenna which transmits radio signals. These signals will hit an object and bounce off creating an echo. This echo will be received and cause a tiny blip to appear on a C.R.T. screen. The direction, altitude, and distance of the object from the radar station can then be accurately computed. Radar communication systems have been proven useful in both peace and war time.

Name: ____________________

Date: ____________________

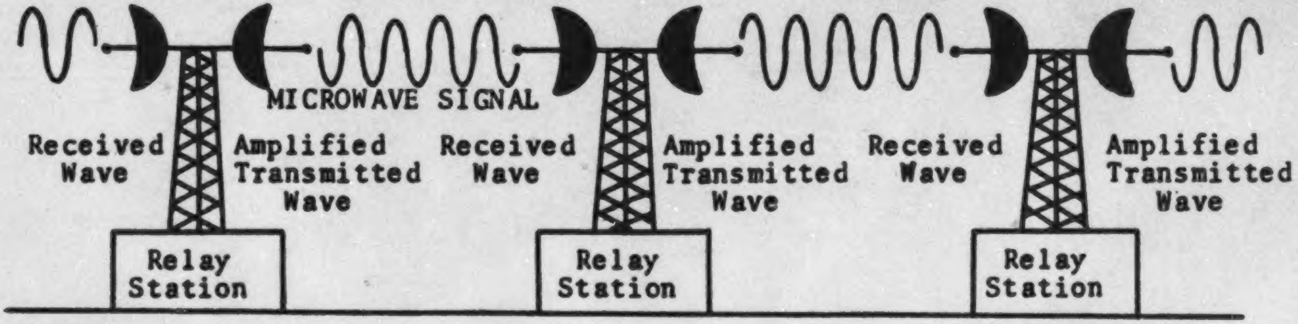
Period: ____________________


Shipboard radar station
RADIO SIGNALS
RETURNING ECHOES
Object

MICROWAVE:

This is a fairly new and efficient method of communication. Microwaves are short, ultrahigh frequency radio signals that travel at the speed of light. They carry telephone, television, telegraph, teleprinter, and other kinds of communications information.

Microwave antennas look a lot different than lower frequency antennas becaus they are used like light reflectors or search lights. Microwaves can only travel in straight lines which means that for great distances many relay stations must be used. The microwave communication system operates just like other systems you have studied with a transmitting and receiving devic


MICROWAVE SIGNAL
Received Wave
Amplified Transmitted Wave
Received Wave
Amplified Transmitted Wave
Received Wave
Amplified Transmitted Wave
Relay Station
Relay Station
Relay Station

SATELLITES:

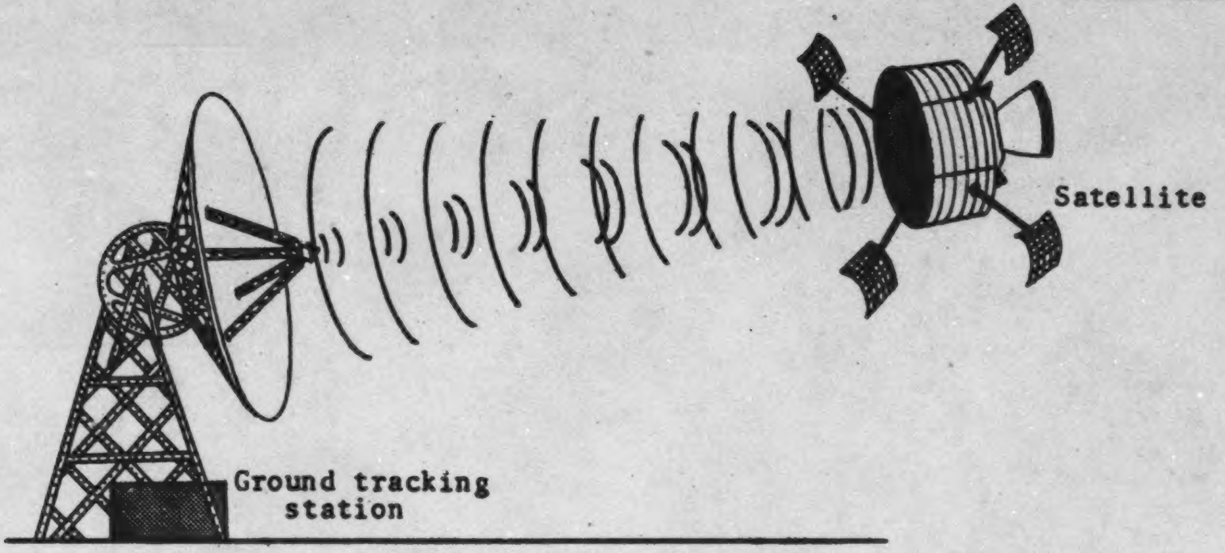
Satellites are part of a communication system between a ground station and a device in orbit around the world. Dozens of satellites are now orbiting the globe providing hemisphere-to-hemisphere communication, weather observation, and environmental information. The first satellite was launched by the Russian's in 1957 and was called "Sputnik."

Satellites generate their power from the sun to continue receiving and transmitting data for long periods of time. Many satellites gather information upon request then send this information to various tracking and communication centers throughout the world.

Name: ____________________

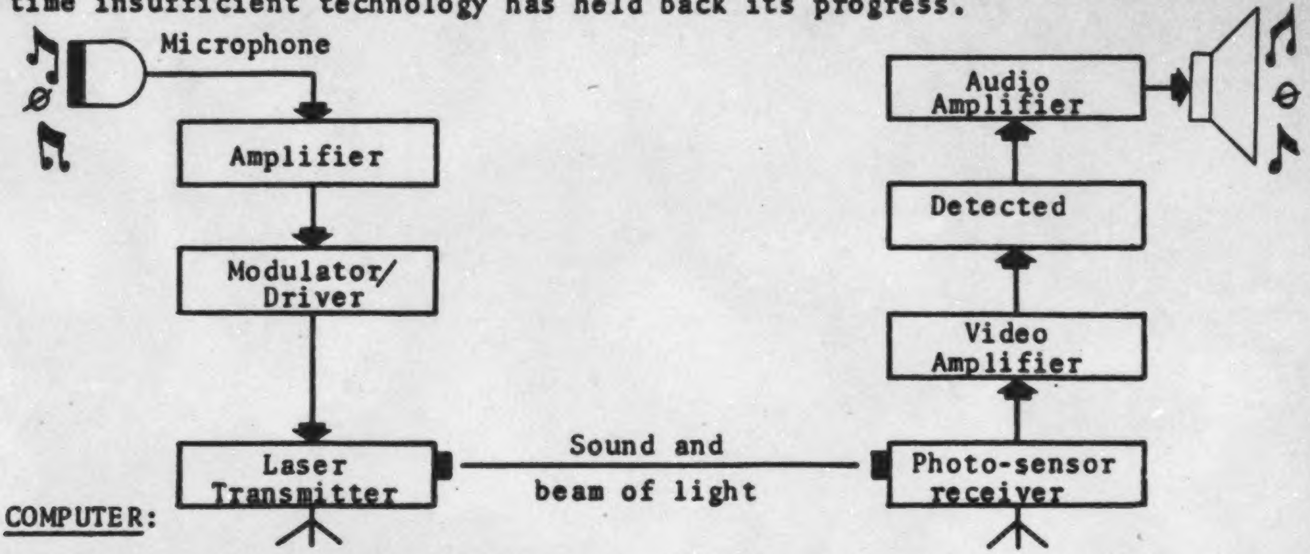
Date: ____________________

Period: ____________________


Satellite
Ground tracking station

LASERS: =(Optical Communication)

Alexander G. Bell in 1880 first proposed several methods of communicating with light, but not until the 1960's did the laser actually develop into a real communication system. It is basically a device which gives off a beam of light energy that is "ordered or directional", and has the ability to carry information. The laser has many other applications besides communication such as cutting or drilling materials. The reliability of mass communication systems utilizing lasers is still under study and at the present time insufficient technology has held back its progress.


Microphone
Amplifier
Modulator/ Driver
Laser Transmitter
Sound and
beam of light
Photo-sensor receiver
Video Amplifier
Detected
Audio Amplifier

COMPUTER:

A basic need of business, industry, and government is the ability to communicate large amounts of information rapidly. Computer communication systems meet this important need. Generally, all computers contain five basic stages: input, output, storage, logic, and control.

Name: ____________________

Date: ____________________

Period: ____________________

The input stage provides the means to feed data into the system.

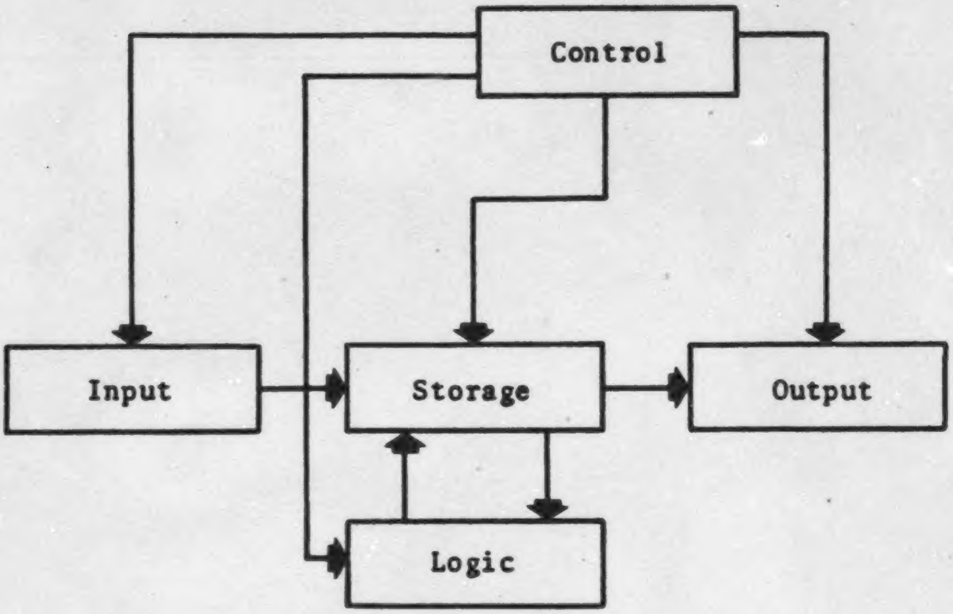
The output stage provides the means to remove data from the system.

The storage stage holds information for future processing.

The logic stage performs the mathematics in order to complete a problem.

The control stage contains the "program" of instructions for the stages to follow when completing a job.

The computer is indeed a powerful communication system now and for the future.



Computer System

SCORE:

GRADE:

Name: ________________

Date: ________________

Period: ________________

ANSWER SHEET

EXAM LII-U21

	T A	F B	C	D		T A	F B	C	D		T A	F B	C	D		T A	F B	C	D
1.	■				26.					51.					76.				
2.	■				27.					52.					77.				
3.		■			28.					53.					78.				
4.		■			29.					54.					79.				
5.	■				30.					55.					80.				
6.		■			31.					56.					81.				
7.	■				32.					57.					82.				
8.		■			33.					58.					83.				
9.		■			34.					59.					84.				
10.	■				35.					60.					85.				
11.		■			36.					61.					86.				
12.			■		37.					62.					87.				
13.	■				38.					63.					88.				
14.				■	39.					64.					89.				
15.			■		40.					65.					90.				
16.	in sync				41.					66.					91.				
17.	solar				42.					67.					92.				
18.	hearing				43.					68.					93.				
19.	message destination				44.					69.					94.				
20.	AM				45.					70.					95.				
21.					46.					71.					96.				
22.					47.					72.					97.				
23.					48.					73.					98.				
24.					49.					74.					99.				
25.					50.					75.					100.				

*Show work for problems on back of answer sheet.

ANSWER KEY
UNIT 21

A. KNOW YOUR DEFINITIONS

1. communication
2. decoder
3. radar
4. radio wave
5. television
5. sync
. carry
8. modulation
9. laser
10. telegraph
11. information
12. microwave

B. COMMUNICATION SYSTEMS

b. For sketch and facts see informational handout.
Block Diagram
source - manual or programmed keying
coder - transmitter
message carrier - air
decoder - receiver
message destination - CRT viewed by operator

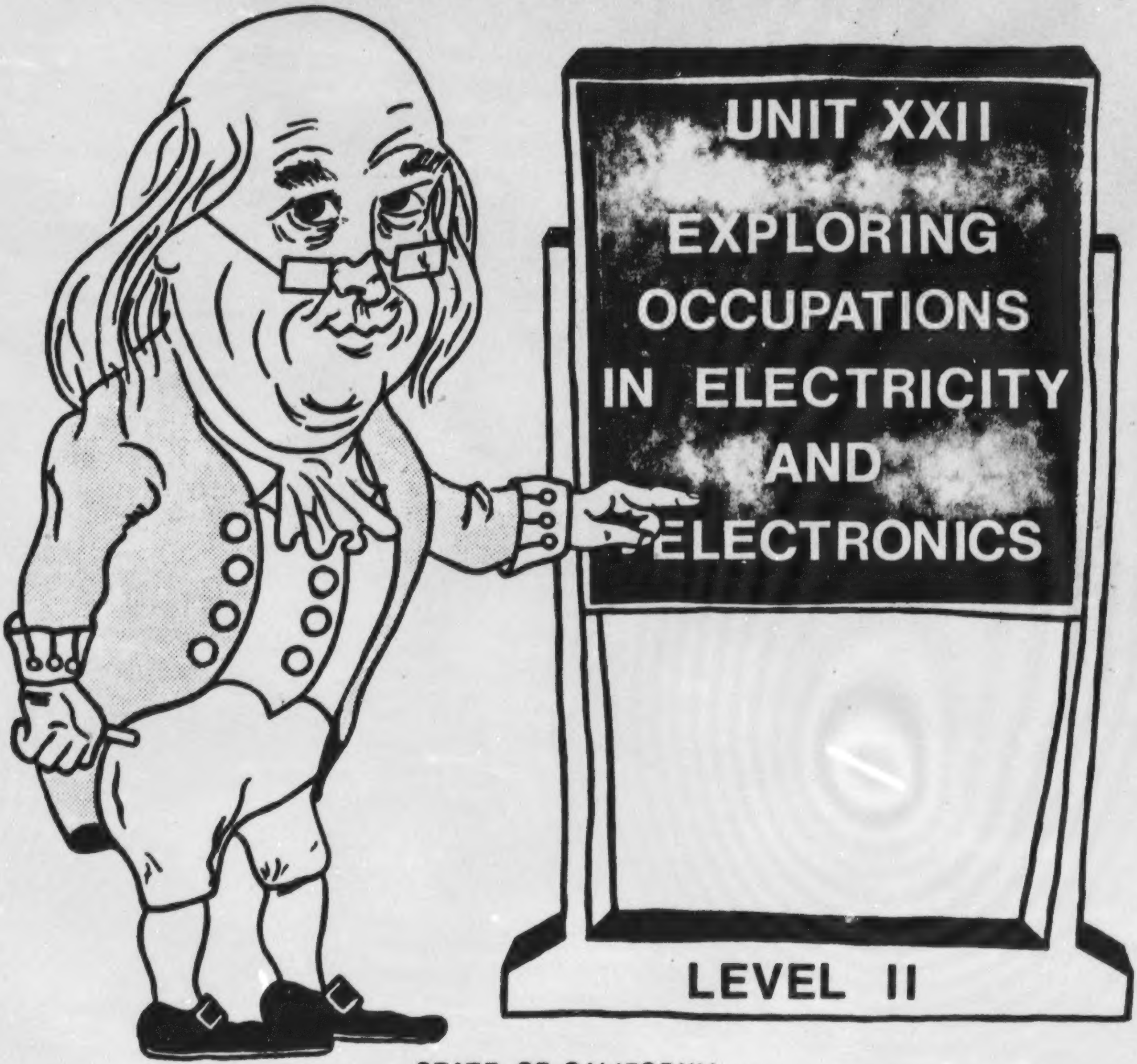
c. For sketch and facts see informational handout.
Block Diagram
source - message content
coder - amplifier and transmitter
message carrier - atmosphere or space
decoder - photo-sensitive receiver
message destination - video and audio amplifiers to viewer

d. For sketch and facts see informational handout.
Block Diagram
source - audio and video program
coder - audio and video transmitter
message carrier - atmosphere or space
decoder - audio and video detectors and amplifiers
message destination - speakers and cathode ray tube

e. For sketch and facts see informational handout.
Block Diagram
source - message content
coder - UHF signal transmitter
message carrier - atmosphere and relay stations
decoder - receiver and amplifiers
message destinition - speaker systems

ELECTRICITY / ELECTRONICS

CURRICULUM GUIDE
INSTRUCTIONAL MODULE


UNIT XXII
EXPLORING OCCUPATIONS IN ELECTRICITY AND ELECTRONICS
LEVEL II

STATE OF CALIFORNIA
DEPARTMENT OF EDUCATION

NAME____________________
DATE STARTED____________
DATE COMPLETED_______

BY
R. E. LILLO
N. S. SOFFIOTTO

STATE ELECTRICITY/ELECTRONICS CURRICULUM GUIDE
INSTRUCTOR'S GUIDE TO ACCOMPANY LEVEL II UNIT #22

Title of Unit: **Exploring Occupations in Electricity and Electronics**

Time Allocation: 1 week

Unit Goal:

To inform students in terms of the necessity of work, kinds of skills necessary to gain employment, and the location of specific occupations within the major Electricity/Electronic occupational families.

Unit Objectives:

The student will be able to:

1. identify the four major occupational families in the Electricity/Electronics area.
2. explain the two kinds or classifications of skills that are generally required to gain technical employment.
3. describe the current occupational forecast for technical jobs pertaining to the Electricity/Electronics field.

Evaluation:

The student will demonstrate his/her competence in terms of these measurable objectives based upon individual instructors acceptable performance criteria, which may utilize a combination of oral, or written testing procedures.

Instructor References:

Exploring Occupations in Electricity and Electronics. Larry Heath, McGraw-Hill Book Co., 1976. Units: 1-8.

Industrial Education Electricity/Electronics Curriculum Guide: Grade Levels 7-14. Robert E. Lillo and Nick S. Soffiotto, State of California, 1977. All.

Your Career in the World of Work. M. Berlye, H.W. Sams, 1975. Chapters:1-1

Overview:

Remember, Unit 22 includes the important instructional topic of guidance which can really support and promote the reasons why the students should continue their studies in this specific industrial subject area.

This unit can be introduced by simply discussing the necessity of work. Focus on such reasons as economic needs, self-worth, social contact, life-style desired, etc.

Next, assist students in locating where the jobs are and how they are classified. Utilizing the unit's flow chart depicting the major Electricity/Electronics occupational families or clusters, identify the four major work areas.

The topic of what skills are really necessary for employment should be presented, however, equal time should be allocated for discussion of both "social" skills and "technical" skills.

This unit should conclude with an overview on the present occupational forecast for this technical field.

Suggested Presentation Hints/Methodology:

Follow the instructional module unit outline as a basic skeleton for curriculum presentation, however, note the following:

1. This unit was included as a means to supplement the school guidance program, hence, draw upon their resources for knowledge related to current films, tapes, or any other audio visual materials that might coordinate with this unit of instruction.
2. Occupational slides can be taken of the specific work areas within each cluster to further dramatize the student's awareness of specific job descriptions. In this way the student will have greater exposure to the many different kinds of technical jobs that can be found in the four major occupational families in the Electricity/Electronics area.
3. Consult the latest edition of the Occupational Outlook Handbook and the Dictionary of Occupational Titles to keep abreast of current information about careers in the Electricity/Electronics field. For more information of this nature contact the U.S. Government Printing Office, Washington 25, D.C.
4. When gathering occupational data for an occupational forecast it is helpful to procure a copy of the latest Area Manpower Report. This report will contain economic outlook projections, trends, population growth, etc. It is available both at the Federal and State level, so check with the proper government employment development agency in your area for further information.

Supplemental Activities and Demonstrations:

1. In addition to prepared occupational forecasts, which primarily refer to future needs, it is advantageous to have students analyze a major urban newspaper's Help Wanted Ads. These kinds of ads can assist in identifying immediate job availability.
2. When discussing where the jobs are, indicate employment decline is mostly found on those jobs requiring less education and training. Have them verbally describe some of these jobs by title while the instructor lists them on the blackboard.
3. Point out that women play an important part in the world of work. Indicate that many work in the Electricity/Electronics industry and that in some companies they outnumber men. Impress upon the students that during the past twenty-five years, more than half of all the new workers added to the American Labor Force have been women.

Instructional Module Contents:

1. Unit Outline (overhead)
2. Pre-Post Test (keyed)
3. Technical Glossary
4. Worksheet (vocabulary) - Word Decoding
5. Worksheet - Necessity of Work
6. Quest Activities
7. Informational Handout (Employment Forecast and Kinds of Training)
8. Unit Module Answer Keys

XXII. Exploring Occupations in Electricity and Electronics

A. Necessity of Work

B. Where Are the Jobs?
  1. Cluster breakdown for electricity/electronics area
    a. Electronic manufacturing and services

    b. Electrical servicing and repair

    c. Electrical construction

    d. Miscellaneous technical occupations

  2. Skills necessary for employment
    a. Technical skills

    b. Social skills

C. Occupational Forecast

Test Number _____

LII-U22

UNIT EXAM

EXPLORING OCCUPATIONS IN ELECTRICITY AND ELECTRONICS

IMPORTANT-

Indicate your responses on the answer sheet only. Fill in the box corresponding to the correct answer to each question - there is only one correct answer for each question.

1. The main reason for work is to earn enough money to buy a car and pay for the insurance. (T-F)

2. An Electricity/Electronics Occupational Cluster refers to a major family of related occupations that may have a common function. (T-F)

3. All jobs require about the same training and preparation. (T-F)

4. The way an individual responds or feels about their career has great importance on their overall satisfaction with life. (T-F)

5. The occupation you select really is only important during the working day and has little influence on your personal life. (T-F)

6. Women are generally unsuccessful in an electronics occupation because of the physical dexterity required. (T-F)

7. Most adults in our society are well satisfied with their income and life style, they indicate that career planning is not that essential to obtaining career goals. (T-F)

8. A quick method of checking the demand in a certain major work area is to read the "Help Wanted" section of your local newspaper. (T-F)

9. Once you can find another employee's mistake a good social skill woul be to force them to admit it and then report the individual. (T-F)

10. People who go into the "assembly" occupational area must have attaine a strong "professional" type training background. (T-F)

11. Society's "role expectations" of males and females should be followed because there are certain careers just for men, and women should not be allowed to enter unless it has been traditional. (T-F)

12. Pressure from your family and friends influences in many ways your career choice. (T-F)

13. If you make a lot of money, it does not really matter whether or not you like the occupation. (T-F)

14. Everyone has a basic need to feel wanted and worthwhile. (T-F)

15. If you want to have friends on the job it is necessary to do all of the talking when having a conversation. (T-F)

Name: ____________________

Date: ____________________

Period: ____________________

TECHNICAL GLOSSARY

CLUSTER:	A group of occupations or jobs that are related or joined together by having similar characteristics or a common purpose.
COMPETENCY:	The skill or knowledge a person needs in order to perform a particular job successfully.
ELECTRICAL CONSTRUCTION:	That cluster of electrical occupations involved with wiring power circuits and auxiliary electrical devices into a building or structure. An electrician is an example of the type of individual found within this job cluster.
AND REPAIR:	That cluster of electrical occupations involved with the repair, installation, wiring, fabrication, adjustment, and maintenance of electrical devices. Sample occupations can be found in the electrical utility, telephone, and appliance repair industries.
ELECTRONIC MANUFACTURING AND SERVICING:	That cluster of electronic occupations involved with supervising, design, assembly, inspecting, testing, servicing, and fabrication of electronic devices. Sample occupations such as assemblers, testers, technicians, and printed circuit board processors are found within this cluster.
FORECAST:	A projection or educated guess, based upon surveys, trends and studies, of the future needs of an industry or occupation. Forecasts are often completed to point out the job needs (openings available or over supply of qualified people) for a particular area or industry.
HIGHLY SKILLED:	An individual, who through proper training has obtained many specialized and complex skills or abilities. This individual is usually very much in demand by industry, and paid an excellent salary. Generally this person will have completed at least two years of college or technical training.
MISCELLANEOUS TECHNICAL OPERATIONS:	That cluster of electronic occupations which includes various specialized jobs within the field of electronics. Sample occupations in this cluster include engineers, teachers, vocational counselors, and radio/TV broadcasting jobs.
OCCUPATION:	The job or type of work that you perform in order to earn a living.

Name: ____________________

Date: ____________________

Period: ____________________

PROFESSIONAL:	An individual who has spent many years in preparation for a "rewarding" and "highly responsible" job. This type of individual generally completes four or more years of college education, often donating many hours of work in order to gain experience. When hired, a professional can expect a very high salary to offset the years of training required. Doctors, lawyers, engineers, etc. are classified as professionals.
SEMISKILLED:	An individual who has aquired a sufficient number of skills to make them readily employable in many occupations. These individuals can usually plan on receiving additional training on the job or at night or at a technical school, to assist them advancing to a better job. Semiskilled jobs ssually require at least a high school education.
SKILL:	The ability to perform a task or job, by applying learned knowledge and/or physical dexterity.
SOCIAL SKILL:	Skills, behavior, or manners needed to work, communicate and "get along" with other people. Social skills involve such things as working efficiently with other people even if you don't like or know them, using your time efficiently, dealing with frustration maturely, using acceptable language, etc.
TECHNICAL SKILL:	A specialized skill, ability, or knowledge required to perform a job or technical task. Soldering, measuring voltage, applying electronic knowledge to solve a circuit problem are examples of technical skills.
UNSKILLED:	A worker who possesses a minimal number of skills or abilities. Unskilled workers usually are paid very low wages, and perform very simple, repetitive tasks. Unskilled workers generally have not finished high school.
WORK:	The labor, tasks, or duties that one performs in exchange for payment, (wages, goods, etc.).

CAREER
SEARCH

SCORE:

GRADE:

Name: ____________________

Date: ____________________

Period: ____________________

WORKSHEET

VOCABULARY - WORD DECODING

The words below have little meaning until they are decoded. Each letter actually represents another letter in the alphabet. Your task is to break the code and decode each word. The example will get you started by providing four decoded letters. The code remains the same through out the worksheet.

EXAMPLE: A. L J Y A A Y A. CAREER

C A R E E R

1. B U Y L J D E 1.

- - - - - - -

2. L U I V A E A T L O 2.

- - - - - - - - - -

3. D U L R J H D G R H H 3.

- - - - - - - - - - -

4. U L L F V J E R U T 4.

- - - - - - - - - -

5. V Y U B A D D R U T J H 5.

- - - - - - - - - - - -

6. L H F D E A Y 6.

- - - - - - -

7. M U Y G 7.

- - - -

8. E A L Q T R L J H D G R H H 8.

- - - - - - - - - - - - - -

9. D A Y Z R L R T C J T P Y A V J R Y 9.

- - - - - - - - - - - - - - - - - -

10. A H A L E Y U T R L I J T F B J L E F Y R T C 10.

- -

SCORE:

GRADE:

Name: ______________________

Date: ______________________

Period: ______________________

WORKSHEET

NECESSITY OF WORK

Answer the following questions in short essay form.

The main reasons why we work are outlined below. In the space provided explain what is specifically meant by that topic title.

WORK??

1. ECONOMIC REASONS:
   (Hint-money, luxuries, etc.)

2. SOCIAL RECOGNITION:
   (Hint-contact, friendships, etc.)

Name: ____________________

Date: ____________________

Period: ____________________

3. EMOTIONAL SATISFACTION:
(Hint-identity, worth, etc.)

Which one of these three topics would be the main reason why you would work - be honest and of course be serious!

SCORE:

GRADE:

Name: ________________

Date: ________________

Period: ________________

WORKSHEET

QUEST ACTIVITY

"UNIT 22"

CAREER RESEARCH IN THE ELECTRICITY/ELECTRONICS AREA

An important part of exploring occupational information involves the collection of specific career data which can possibly be utilized in forming an appropriate career goal.

Referring to the attached Electricity/Electronics Organizational Cluster Chart, and all other career resource materials available in the classroom, complete the following occupational profile as directed.

Select "1" occupation which interests you from any Major Work Area found within a particular Cluster and use the format indicated below as a layout guide. Turn in a neat profile and answer all questions.

Name: ____________________ Due Date: ________________

I. Research profile # _____

II. Name of Major Work Area selected: ____________________

III. Basic duties and responsibilities:

IV. Specific working conditions:

V. Salary range:

VI. Present and future occupational outlook in this career:

VII. Educational and/or special training requirements:

VIII. Availability of local educational or training institutions:

IX. Advantages and disadvantages of this career choice:

X. List your sources of information in completing this profile (bibliography):

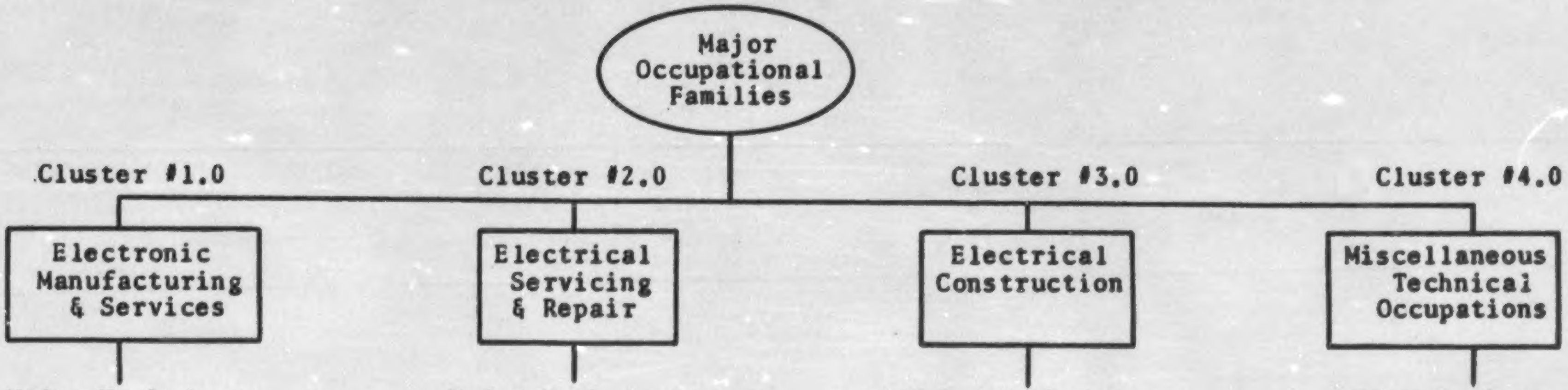
Name: ____________________

Date: ____________________

Period: ____________________

WORKSHEET

CAREER RESEARCH IN THE ELECTRICITY/ELECTRONICS AREA


Major Occupational Families
Cluster #1.0
Electronic Manufacturing & Services
Cluster #2.0
Electrical Servicing & Repair
Cluster #3.0
Electrical Construction
Cluster #4.0
Miscellaneous Technical Occupations

Major Work Areas	Major Work Areas	Major Work Areas	Major Work Areas
1.1 Processing	2.1 Electrical Instrument	3.1 Electricians	4.1 Engineering
1.2 Assembly preparation	2.2 Coil, Motor, and Generator	3.2	4.2 Education
1.3 Assembly	2.3 Appliance and Fixture	3.3	4.3 Radio/Television Broadcasting
1.4 Inspecting and Testing	2.4 Communication Equipment	3.4	4.4
1.5 Set-up Maintenance	2.5 Transportation Equipment	3.5	4.5
1.6 Technician	2.6 Electrical Utilities	3.6	4.6
1.7 Special Occupations	2.7 Misc. Electrical Equipment	3.7	4.7
1.8 Supervising	2.8	3.8	4.8
1.9 Repair and Servicing Electronic Equipment	2.9	3.9	4.9

LII-U22-12

Name: ____________________

Date: ____________________

Period: ____________________

INFORMATIONAL HANDOUT

EMPLOYMENT FORECAST AND KINDS OF TRAINING

Forecast:

A variety of technical opportunities for employment in California will be available if you attain the skills necessary within the educational process. Employers are seeking individuals who posseses higher levels of technical education because many occupations are complex and require greater skill. In the past, employment growth generally has been faster in those occupations requiring the most education and/or training.

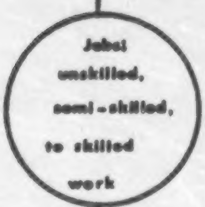
Entry level occupations that require a minimum of high school education, including some technical training, still demand basic or fundamental skills in order to survive. Employers agree that young people who have acquired skills and a good education will have a better opportunity for satisfying employment, greater wages, and security of employment.

Employment in the Electricity/Electronics area and its related occupational families is expected to increase faster than the average for all industries through the middle 1990's. In addition to the occupations resulting from employment growth, large numbers of openings will arise through normal vacancies created by retirement, death, and employee occupation change.

Although employment in the Electricity/Electronic area is expected to grow over the long run, it may fluctuate from year to year among occupational clusters and/or major work areas.

3 Preparation Systems

1. ENTRY LEVEL OCCUPATIONS



Requirements: Graduation from high school or R.O.C. with as many possible electives in math, drafting, metals, and of course Electricity/Electronics. These basic skills will be of immediate help in entering an industry. Read magazines and books on basic Electricity/Electronics. Remember you will get on-the-job training once you are hired. Night school or a home study course will assist you in promotions or a better paying job within the company.

Name: ____________________

Date: ____________________

Period: ____________________

2. FURTHER TECHNICAL TRAINING

Jobs:
skilled,
highly skilled,
professional
work

Requirements: Graduation from high school with as many possible electives in math, science, drafting, metals, and of course Electricity/Electronics. Additional technical training can occur at a technical institute, community (junior) college, and/or military training program. Many of these advanced training institutions have a placement service to assist students in locating immediate employment after graduation. A certificate or degree is usually granted upon successful completion of a 1-2 year program.

3. PROFESSIONAL TRAINING

Jobs:
management
professional
work

Requirements: Graduation from high school with as many possible electives in math, science, Electricity/Electronics, and other prerequisite college courses. This kind of training will occur in a college or university with a time committment of about four years. Entrance requirements for colleges and universities vary greatly, so check with your counselor to make sure you can meet the requirements of the college of your choice. Keep in mind that for some engineering careers two or more years of graduate work is necessary past the regular degree.

GOOD LUCK!

SCORE:

GRADE:

Name: ____________________

Date: ____________________

Period: ____________________

ANSWER SHEET

EXAM LII-U22

	T A	F B	C	D		T A	F B	C	D		T A	F B	C	D		T A	F B	C	D
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25.					50.					75.					100.				

*Show work for problems on back of answer sheet.

ANSWER KEY
UNIT 22

A. WORD DECODING

1. forecast
2. competency
3. social skill
4. occupation
5. professional
6. cluster
7. work
8. technical skill
9. servicing and repair
10. electronic manufacturing

B. NECESSITY OF WORK

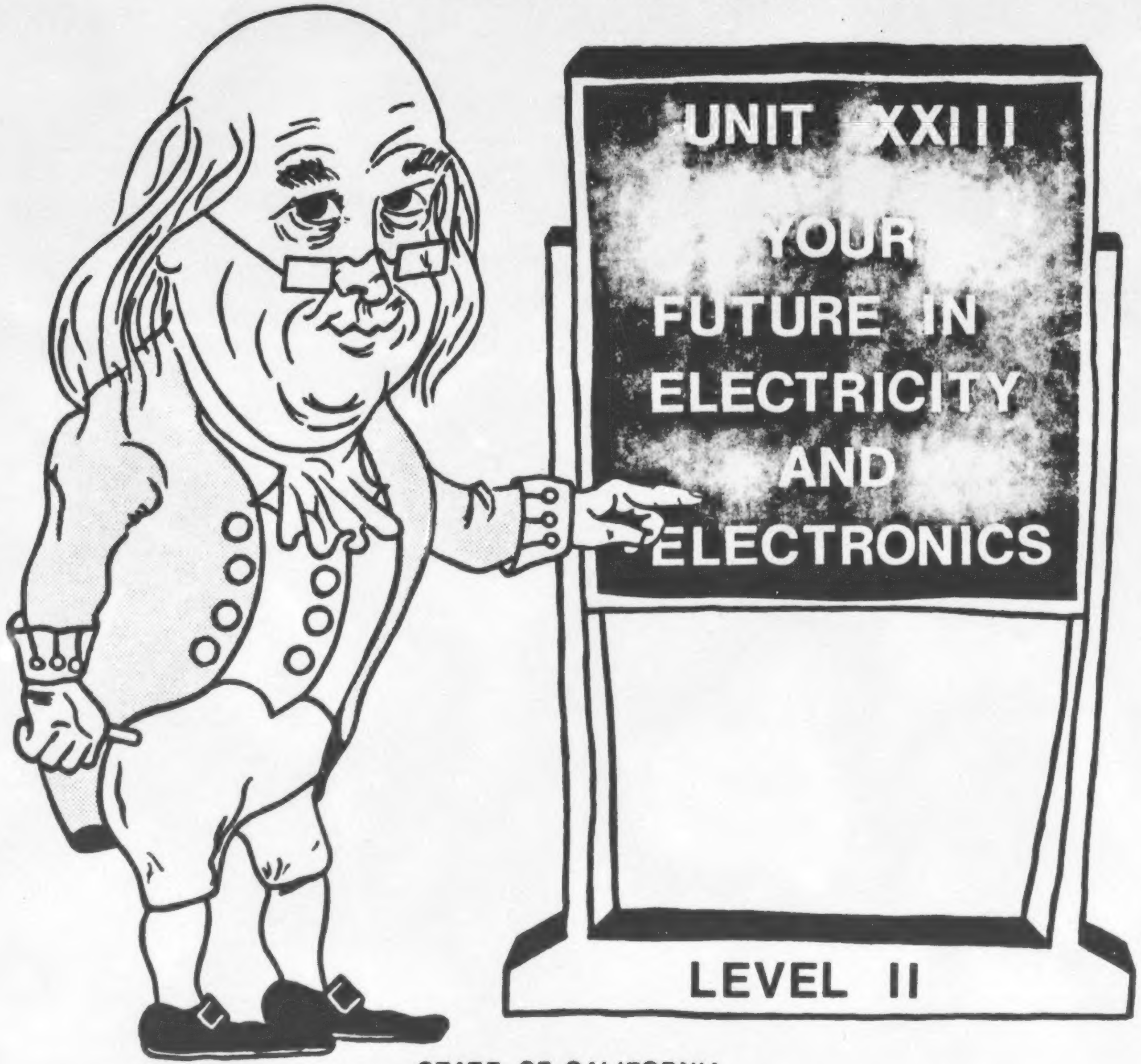
1. (subjective answer)
2. (subjective answer)
3. (subjective answer)

C. QUEST ACTIVITY

(subjective evaluation)

ELECTRICITY / ELECTRONICS

CURRICULUM GUIDE
INSTRUCTIONAL MODULE


UNIT XXIII
YOUR
FUTURE IN
ELECTRICITY
AND
ELECTRONICS
LEVEL II

STATE OF CALIFORNIA
DEPARTMENT OF EDUCATION

NAME____________________
DATE STARTED____________
DATE COMPLETED__________

BY
R. E. LILLO
N. S. SOFFIOTTO

STATE ELECTRICITY/ELECTRONICS CURRICULUM GUIDE
INSTRUCTOR'S GUIDE TO ACCOMPANY LEVEL II UNIT #23

Title of Unit: **Your Future in Electricity and Electronics**

Time Allocation: **1 week**

Unit Goal:

To further acquaint students with the process of occupational exploration through awareness.

Unit Objectives:

The student will be able to:

1. **Indicate in writing or verbally those methods of job selection typically utilized when researching a possible occupational choice**
2. **select one occupation that personally comes closest to their individual abilities, interest, and attitudes.**
3. **explain the essential preparation or training necessary to fulfill the qualifications for entering the specific occupation they have selected.**

Evaluation:

The student will demonstrate his/her competence in terms of these measurable objectives based upon individual instructors acceptable performance criteria, which utilizes a combination of oral, or written testing procedures.

Instructor References:

Exploring Occupations in Electricity and Electronics. Larry Heath, McGraw-Hill Book Co., 1976. Units: 1-8.

Introduction to Electronics. Clyde Herrick and Bill Deem, Goodyear Publishing Company, Inc. 1973. Chapter: 2.

Your Career in the World of Work. Milton K. Berlye, Howard W. Sams Co., 1975. Chapters: 1-13.

Overview:

Unit 23 is the last unit of this level, and represents a natural culmination point for all of the previous activity at this level, however, it can also be thought of as the "hook" in assisting students into the field of electronics.

The introductory topic deals with the basis of self assessment and its relationship to the overall job selection process. Emphasis on what kind of person "I" represent today and what type of person "I" desire to be are essential when analyzing the selection process along with such considerations as salary, qualifications, working conditions, etc.

The next instructional topic presents an overview on basic occupationa research techniques and methods of obtaining additional occupational information.

Unit 23 can be incorporated into Unit 22 or presented separately to facilitate the instructor's time line.

Suggested Presentation Hints/Methodology:

Follow the instructional module unit outline as a basic skeleton for curriculum presentation, however, note the following:

1. Check the yellow pages of the telephone book for electronic manufacturing firms. Locate a company that will allow a school field trip through their establishment and take time with the company's representative to describe the kinds of things that the students would be interested in viewing.
2. Do not forget to reemphasize the sheer value of work in a person's life. Review the idea that most people work for economic social, and psychological (emotional) reasons. Remember to explain to students to be honest and realistic when completing all personal inventories within this unit.
3. Check with your local guidance counselor or career center to see if you can obtain several aptitude and interest inventories tests. These kinds of tests can enable students to develop valuable insight into their strengths/weaknesses, and likes/dislikes. The results of these tests, combined with some tough self-evaluation, can help point them in the right direction.
4. Indicate to students that these tests do not measure motivation, personality, or ambition. They do show fairly accurately what you can do or what you like to do, but the individual must decide what they actually will do!

Supplemental Activities and Demonstrations:

1. A free publication worth writing for from HEW, is a flyer describing five programs for student assistance. This flyer further explains the conditions under which one may apply and where applications may be obtained. Order D.H.E.W. Publication No. (OE) 77-17907 from the Department of Health, Education and Welfare, Office of Education, Washington, D.C. 20202.
2. To obtain information in reference to apprenticeship programs write the National Apprenticeship Program; U.S. Department of Labor, Employment, and Training Administration, Room 10225, Patrick Henry Building, 601 D. Street, N.W. Washington, D.C. 20213.
3. For more career information describing training programs and tips on job finding, contact; Manpower Administration, U.S. Department of Labor, Washington, D.C. 20210.

Instructional Module Contents:

1. Unit Outline (overhead)
2. Pre-Post Test (keyed)
3. Technical Glossary
4. Worksheet (vocabulary) - Know Your Definitions
5. Worksheet - Personal Profile Analysis
6. Quest Activities
7. Informational Handout (Interest and Ability Inventories)
8. Unit Module Answer Keys

XXIII. Your Future in Electricity and Electronics

A. Personal Interest Inventory

B. Possible Career Choices

Test Number _____

LII-U23

UNIT EXAM

YOUR FUTURE IN ELECTRICITY AND ELECTRONICS

IMPORTANT-

Indicate your responses on the answer sheet only. Fill in the box corresponding to the correct answer to each question - there is only one correct answer for each question.

1. Researching careers is the process of carefully studying information about many different occupations. (T-F)

2. The Dictionary of Occupational Titles is helpful when learning how to spell or define an occupation. (T-F)

3. Choosing a career occupation is generally easy and requires very little thought. (T-F)

4. Personal abilities are of little importance in selecting a career. (T-F)

5. A desire to be clean and neat in appearance should have nothing to do with a career choice. (T-F)

6. Part of getting to know and understand yourself is to evaluate your interests. (T-F)

7. Finding a career occupation is generally mostly a matter of blind luck. (T-F)

8. When selecting a career goal it may be wise to determine what the future needs might be for that selection. (T-F)

9. As long as you know the "right" people it is smart to disregard the educational or training requirements of an occupation. (T-F)

10. School grades, attendance, and tardies are usually ignored by potential employers. (T-F)

Name: ____________

Date: ____________

Period: ____________

TECHNICAL GLOSSARY

APTITUDE TEST:	A type of test used to assist in measuring or gauging your probable success and ability in special areas. A common aptitude test is the S.A.T. test, a college entrance exam used to predict your learning success in college. The A.S.V.A.B. exam (Armed Service Vocational Aptitude Battery) tests abilities in vocational areas or subjects.
INTEREST INVENTORY:	A research questionnaire or test used to determine or locate your personal interests. This information can then assist you in selecting an occupational area or a number of jobs which incorporate your identified interests.
OCCUPATIONAL SEARCH:	The process of studying and surveying many occupations - identifying major duties, requirements, working conditions, wages, employment forecasts, advancement possibilities, and training needs.
QUALIFICATIONS:	A list of achievements, accomplishments or qualities an employer will look for when considering an individual for employment.
SELF EVALUATION:	An honest, hard, look at yourself to determine your personal strengths, weaknesses, problems, and concerns. An honest self-evaluation can help in setting a realistic occupational goal.

?
JOBS
?
LIKES
FUTURE
INTEREST
?
DISLIKES
APTITUDE
?
BASIC
ELECTRONICS
STUDIES

SCORE:

GRADE:

Name: ____________

Date: ____________

Period: ____________

WORKSHEET

VOCABULARY - KNOW YOUR DEFINITIONS

Develop a short definition, using your own words, for the following terms.

1. OCCUPATIONAL SEARCH:

2. QUALIFICATIONS:

3. SELF-EVALUATION:

4. INTEREST INVENTORY:

5. APTITUDE TEST:

SCORE:

GRADE:

Name: ________________

Date: ________________

Period: ________________

WORKSHEET

PERSONAL PROFILE ANALYSIS

All of us want to be "successful" yet to achieve this end we must plan our occupational choice and assess our individual abilities, interests, and attitudes honestly.

To begin with, you must be "aware" of the person you are, thus the purpose of this assignment becomes obvious.

Complete the following personal profile in detail and again be completely honest in evaluating your assets and liabilities.

I. Personality

Use a check (✓) when completing this section!

Personality Profile

Trait	Good	Fair	Poor
Attitude			
Courtesy			
Dependability.			
Drive.			
Health			
Honesty.			
Humor.			
Initiative			
Loyalty.			
Morality			
Neatness			
Personal appearance.			
Pleasantness			
Punctuality.			
Sincerity.			
Tact			
Temperament.			

Personality Profile Analysis:

My personality has several strong points as indicated on the Personality Profile. Listed below are what I feel are the most attractive traits.

1. ________________
2. ________________
3. ________________
4. ________________

Name: ________________

Date: ________________

Period: ________________

I have also discovered a need to improve these specific traits.

1. ______________ 3. ______________

2. ______________ 4. ______________

II. Interest

The hobbies that interest me the most at present are as follows:

1. ______________ 3. ______________

2. ______________ 4. ______________

The classes in school that are the most exciting to me are:

1. ______________ 3. ______________

2. ______________ 4. ______________

I have always like to work with: (check 1 or more)

People	Things	Ideas	All
☐	☐	☐	☐

III. Abilities

My main scholastic attributes are: (check 1 or more)

Reading	Verbal	Mechanical	Mathematical
☐	☐	☐	☐

My overall grade point average in high school to date is: ________

IV. Values

Indicate your ranking of the specific values listed. Use a number only once and the most important value should be labeled #1 and the least important value #10. Place your personal rating in the circle provided.

Name: ____________________

Date: ____________________

Period: ____________________

(value)	(rating)	(value)	(rating)
Fame	○	Family	○
Health	○	Money	○
Power	○	Religion	○
Humanism	○	Social	○
Creative	○	Artistic	○

V. **Decision**

Considering the information on this profile and other career assessment data, I feel that I would like to further explore careers related to:

____

Career Exploration

SCORE:

GRADE:

Name: ______________________

Date: ______________________

Period: ______________________

WORKSHEET

QUEST ACTIVITY

"UNIT 23"

List three places where you can find information about occupations:

1. ______________________
2. ______________________
3. ______________________

In the space provided indicate three possible occupational choices for yourself and the training requirements for entering into that occupation, then indicate under which cluster this occupation can be found.

① Occupation Title: ______________________ Cluster ________

Basic Training Requirements ______________________

② Occupation Title: ______________________ Cluster ________

Basic Training Requirements ______________________

③ Occupation Title: ______________________ Cluster ________

Basic Training Requirements ______________________

In the space provided, indicate the present and expected needs for workers for the "3" choices indicated above.

① - The need for workers in this occupation now is:

(A) Locally: ______________________
(B) Statewide: ______________________
(C) Nationally: ______________________

Comments: ______________________

____

The expected future need for workers in this occupation is:

(A) Locally: ______________________
(B) Statewide: ______________________
(C) Nationally: ______________________

Comments: ______________________

Name: ____________

Date: ____________

Period: ____________

② - The need for workers in this occupation now is:
(A) Locally: ____________
(B) Statewide: ____________
(C) Nationally: ____________

Comments: ____________

The expected future need for workers in this occupation is:
(A) Locally: ____________
(B) Statewide: ____________
(C) Nationally: ____________

Comments: ____________

③ - The need for workers in this occupation now is:
(A) Locally: ____________
(B) Statewide: ____________
(C) Nationally: ____________

Comments: ____________

The expected future need for workers in this occupation is:
(A) Locally; ____________
(B) Statewide: ____________
(C) Nationally: ____________

Comments: ____________

I used the following resource materials to "verify" answers in this Quest Activity:

1. Title: ____________ Pages: ______
2. Title: ____________ Pages: ______
3. Title: ____________ Pages: ______

Name: ______________

Date: ______________

Period: ______________

INFORMATIONAL HANDOUT

INTEREST AND ABILITY INVENTORIES

Having an interest in an occupation is important but it just might not be enough, you must also have the ability or a combination of abilities in order to fulfill your career goal.

Have you ever stopped to analyze both your interests and abilities?

To be successful in selecting the proper occupation for you, this is a must.

Interest Inventory = A general test of your overall likes and dislikes.

Abilities Inventory = A simple test of your talents in terms of performance strengths and weaknesses.

GENERAL INTEREST AND ABILITY INVENTORY

After each of the following general interest or ability descriptions, place a check in the column which best describes you!

My own feelings (use a check √)	Really Enjoy A	Like B	Maybe ? C	Dislike D	I Hate It E
1. Being my own boss					
2. Working alone					
3. Working with equipment					

Name: ____________________

My own feelings (use a check √)	Really Enjoy A	Like B	Maybe ? C	Dislike D	I Hate It E
4. Traveling a lot					
5. Making accurate measurements					
6. Working on a project					
7. Analyzing costs					
8. Figuring data					
9. Supervising others					
10. Preparing reports					
11. Repairing objects					
12. Making things in a shop					
13. Working with tools					
14. Selling things					
15. Speaking before groups					
16. Following others					
17. Directing others					
18. Reading books					
19. Studying					
20. Attending school					
21. Keeping accurate records or notes					
22. Collecting bills					
23. Working to close specifications					
24. Doing the same work					
25. Getting up early					
26. Sleeping late					
27. Working at night					
28. Able to read or play music					
29. Being imaginative, creative					
30. Able to study problems and solve them					
31. Artistic					
32. Accurate in detail work					
33. Good at grammar, spelling					
34. Good at science, math					
35. Concerned about the problems of people					
36. Prefer outdoor work					
37. Able to type accurately					
38. Able to work under pressure					
39. Prefer desk work					
40. Comfortable meeting new people					
41. Seldom tardy or absent					
42. Being neat, attractive appearance					
43. Prefer to work as part of a team					
44. Well coordinated					
45. Being healthy					

Name: ____________________

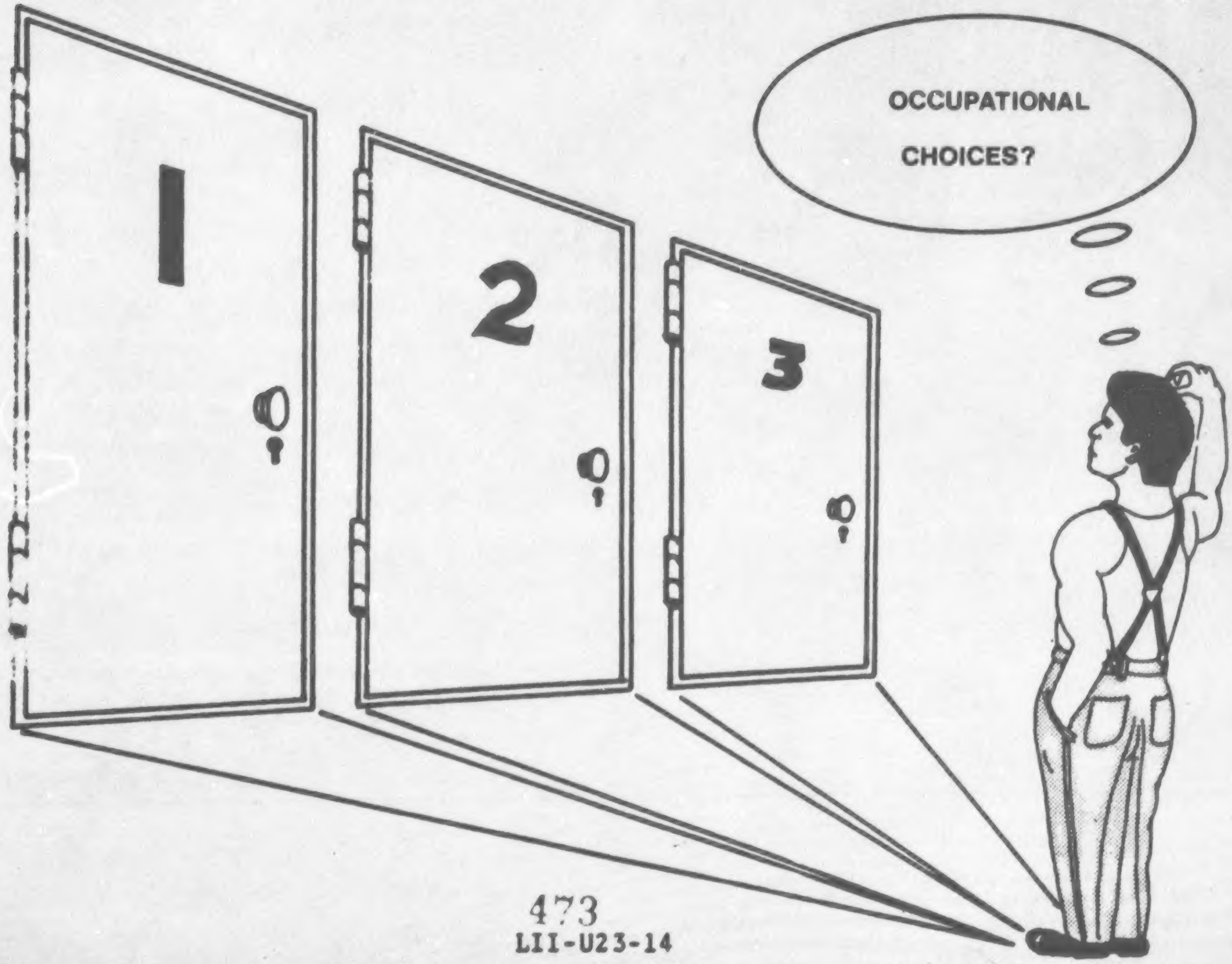
Date: ____________________

Period: ____________________

Now review your answers from this general Interest Inventory. Especially look at the rows on each end because they might influence a future career choice.

BE HONEST!

Getting to know yourself a little better is the first step in career awareness. You will do a much better job, and be a much happier person, if you really enjoy your occupation.



SCORE:

GRADE:

Name: ______________________

Date: ______________________

Period: ______________________

ANSWER SHEET

EXAM LII-U23

	T A	F B	C	D
1.	■			
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3.		■		
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99.				
100.				

*Show work for problems on back of answer sheet.

ANSWER KEY
UNIT 23

A. KNOW YOUR DEFINITIONS

1. (subjective answer)
2. (subjective answer)
3. (subjective answer)
4. (subjective answer)
5. (subjective answer)

B. PERSONAL PROFILE ANALYSIS

(subjective evaluation)

C. QUEST ACTIVITY

1. Dictionary of Occupational Titles
2. Occupational Outlook Handbook
3. California Occupational Guides

Remainder of questions have subjective answers.